The Electrical World.

VOL. XXV. NEW YORK, JUNE 29, 1895. No. 26.

PUBLISHED EVERY SATURDAY BY

THE W. J. JOHNSTON COMPANY, Limited,

253 Broadway, New York.

Established 1874. Incorporated 1889.

Telephone Call: Cortlandt 924. Cable Address: "Electrical," New York.

New England Office, 620 Atlantic Ave., Boston.

Western Office, 936 Monadnock Block, Chicago.

Philadelphia Office, 927 Chestnut Street.

SUBSCRIPTION IN ADVANCE, ONE YEAR, $3.00,

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THE OUTPUT OF POLYPHASED MACHINERY.

In another column we print a letter from Mr. R. D. Mershon, correcting a wrong impression conveyed in an editorial comment on the article from his pen, contained in our last issue. As will be seen, the deductions made in the article referred to were based upon a constant copper and iron loss, and therefore the increased output in polyphased machinery, under the conditions named, is an absolute instead of relative one, as suggested by us. The article in question is an important contribution to the subject of polyphased machinery, not only from the practical weight of its conclusions, but also from the value of the analytical method employed in demonstrating them.

TESTING OF ALTERNATORS.

Dr. Behn-Eschenberg, of the Oerlikon Works, describes in another column a method of testing alternating-current dynamos, which is claimed to give direct values suitable for an exact comparison of the various factors entering into the efficiency of alternators. The method appears to be simple, and as to its theoretical exactitudes, the assurance of Dr. Eschenberg is, of course, sufficient. The principles of the method are in line with those involved in Mr. Kapp's tests for transformers, described in the Digest of several weeks ago, and these two contributions to the practical side of alternating work go far toward putting this branch on a plane with direct current practice with respect to ease of determining the necessary efficiency data.

THE THEORY OF UNITS.

Prof. Fessenden in this issue answers the objections raised in our columns by Mr. Townsend Wolcott, apropos of two previous articles from the pen of the former, and we gladly offer the use of our columns to others for the discussion of the issue which is now so clearly established. Fortunately, the proposed change in the value of our present units does not affect the main points of the theory offered, as otherwise we fear that it would meet with little favor. One notable advantage which this theory does offer is a rational basis for the dimensional expression of the ohm and henry, which thereby is freed from the reproach of posing in the false character of a velocity and a length, respectively. As tending to remove the difficulty which has existed in the minds of students and others as to these and other points, it promises to perform a good service, and, therefore, deserves careful attention.

AMERICAN BELL AND WESTERN UNION.

Some comment was caused during the past week by the retirement from the directorate of the Philadelphia Bell Telephone Company of all but one of several representatives of the Western Union Telegraph Company. As the contract will soon expire between the American Bell and the latter company which confines each to a definite sphere of activity, much interest as to their prospective policy naturally exists, and it was thought by some that the action referred to presaged an invasion of each into the present field of the other. As far as we can ascertain, however, there is no ground for such a construction upon the result of the election, it appearing to be simply the case of a minority dispossessed in the usual way from purely business considerations. It is, of course, quite possible that in due time these two giant corporations may lock horns, in which case it would seem that the general public has nothing to lose and much to gain. On the face it would seem that the American Bell has the stronger position, as it would merely have to open offices in its exchanges to enter the telegraph business, while the Western Union would be handicapped in the long-distance telephone field

by the lack of local connections. As both of the corporations are aggressive and tenacious of their purpose, should the struggle come it will be a battle royal, and one from which the public is likely to obtain a goodly share of the spoils.

RESUSCITATION FROM ELECTRIC SHOCK.

As our readers are aware, we have earnestly advocated the necessity of electricians acquainting themselves with the methods to be pursued in case of suspended animation from electric shock, and in our columns this week we print a striking confirmation of the wisdom of this advice. The case of Mr. Grover, at Rochester, is a parallel to the one mentioned by D'Arsonval which led our attention to the subject, and the evidence is now overwhelming that one apparently dead from electric shock may be resuscitated. In the present instance the men who applied the instructions of Dr. Goelet, as contained in the poster distributed to central stations by THE ELECTRICAL WORLD, deserve particular credit for not ceasing their labors with the patient, notwithstanding that no signs of life became apparent for over half an hour. They doubtless feel that they have an infinite reward in having saved a useful life, and the electricians of the world are indebted to their faith for what ought to be considered the final test of a method which should be mentioned among the boons to humanity. In sad contrast to the Rochester case are those reported elsewhere from Harrisburg, Pa. We feel thoroughly convinced that had the proper means of resuscitation been here applied, at least one of the lives, and very probably both, would have been saved. In conclusion we think we may say that after the demonstration at Rochester, the managers of electric plants should feel that a responsibility rests with them in the matter of providing for the necessary aid in case of electric shock, for further deaths from this cause through the absence of that aid can reasonably be considered in the light of a sacrifice of human life.

POLYPHASED CURRENTS.

For the benefit of those of our readers who wish to read a simple, non-mathematical explanation of the principles of polyphased currents, we print in another column an article giving the main outlines of the subject in terms that require no previous knowledge on their part. We would here emphasize the fact that polyphased currents in themselves possess no peculiarity, but are simply two or more ordinary alternating currents differing in phase—that is, while having the same mean value, yet not reaching a given identical value at the same instant of time. In fact, polyphased currents may be considered as simple alternating currents developed in two or three distinct machines according as they are two-phased or three-phased; the only thing to be borne in mind is that the several currents must be considered to bear a definite phase relation to each other, which idea may be fixed by considering the separate alternators to have their armatures rigidly fixed on the same shaft, and that when the winding of the one is in one part of its field the winding of the other will be in a relatively different position with respect to the first field. The fact that there may be only three instead of four exterior conductors in a two-phased system or three instead of six in a three-phased system does not alter the conditions named, for the currents in the connections made with these conductors are precisely the same in character as if the even numbers of wires leading from separate alternators were used. The distinctive properties of polyphased systems are developed in the external receptive devices; in a four-pole, two-phased motor, for example, when one pair of poles has a maximum strength the other pair has a minimum strength; on the other hand, the first pair has then a minimum inductive effect on the closed-circuit armature, while the second set has a maximum current-producing effect on the coils of the armature. The result of this is that the strong current produced by the second set flows in the armature under the poles of the first set, thus producing a torque exactly as in a continuous-current motor. We should add that the application here made of the word *armature* is arbitrary; a more rational nomenclature would designate it the revolving secondary, the other element of the motor in this case being called the stationary primary.

Death of Henry W. Frye.

Mr. Henry W. Frye, until recently an associate editor of THE ELECTRICAL WORLD, died near Folsom, N. M., on June 20, of consumption. Last fall Mr. Frye contracted a severe cold, which developed into pneumonia, and upon his recovery from the latter disease it became sadly apparent that his lungs were affected. At the beginning of the year, upon the advice of his physician he reluctantly gave up the editorial work to which he was so attached, and went to New Mexico, and it was fondly hoped by his friends that the dry climate of that region would rapidly recuperate his health. Unfortunately the weather there during the past season has been extremely unfavorable for an invalid and this, coupled with over-exertion in riding while residing on a ranch, led to the sad end.

Henry Wakefield Frye was born at Belfast, Me., April 21, 1868, and was, therefore, but a little over 26 at the time of his death. Part of his early life was passed at Halifax, N. S., where, for many years, his father was United States Consul. After graduating from Colby University, of Maine, he followed the electrical course of Dr. Duncan at Johns Hopkins University until his acceptance in April, 1892, of a position on the editorial staff of THE ELECTRICAL WORLD.

The death of Mr. Frye is a regretable loss to electrical journalism, for aside from his technical qualifications and the possession of a graceful literary style, he had in a high degree that sense of editorial truth and honor which Dana has pronounced so essential to the usefulness of the newspaper press, and which qualities are even more desirable in technical journalism. Ever conscious of the duty imposed by this responsibility, no labor was too arduous in the verification of facts, and no care too great in the preparation of editorial matter, that it might give rise to no wrongful interpretations on the part of readers oftentimes too busy to more than cursorily examine it. With him carelessness in these respects involved a breach of faith toward the reader, and even a slight error took on the aspect of an inexcusable offense.

In his personal relations Mr. Frye was warmly sympathetic, while a geniality of manner and frank sincerity of expression added to the appreciation in which he was held by those who had the pleasure of his acquaintance. Though somewhat retiring in disposition, this, as is often the case, was rather to be ascribed to the presence of the qualities already mentioned than denoting any lack of sociability. Possessed of an elevated character and with a keen sense of moral duty in all of his actions and thoughts, his loss is to be deplored outside of the circle of his friends, for in him the world lost a real force on the side of its nobler aspirations.

A New Use for Accumulator Grids.

The return of the hot weather reminds us, says the London *Electrician*, of an instance of the novel use to which an ingenious mind can put a secondary battery plate. Not a hundred miles from Farringdon Street there was to be seen last summer the grid of a secondary-battery plate of well-known type. As in ordinary practice, it lay in a glass cell; it also had an acid electrolyte, but the vessel was a cylindrical bowl and the electrolyte dilute "lemon squash." The use to which the grid was put was to keep in position the metal syphons used, a few of the meshes of the grid being cut away to admit the end of the syphon, and the corners of the grid were turned down, to keep it well clear of the bottom. It would be interesting to know how the owner of the business came into possession of the plate; also the effect of the liquid (which had to pass through the meshes of the grid) upon the internal economies of its consumers.

American vs. English Electro-Therapeutics.

Referring to two recent pamphlets on electro therapeutics, one by an English and the other by an American author, the London *Electrical Review* characterizes the former as an apology for the existence of scientific truths, professionally slighted and neglected, and the other as a bald statement of work done and advance made in the practical working of these same truths, professionally accepted. What a comment, it adds, on the conservatism of the medical profession in England!

The National Independent Telephone Association of the United States.

A meeting of the recently formed Association of Telephone Manufacturers was held at Pittsburg on Monday, June 24, for the purpose of forming a permanent organization for the protection of the interests of the independent telephone manufacturing companies of the country.

J. E. Keelyn, president of the Western Telephone Construction Company, of Chicago, the prime mover in the organization idea, presided. After several addresses, committees were appointed to look over the various plans presented by the delegates. The committees reported at the afternoon's session, at which the permanent organization, under the name National Independent Telephone Company of the United States, was effected.

On Tuesday the following directors were chosen: J. E. Keelyn, Chicago; J. R. Johnson, Baltimore; S. J. Tunbridge, Utica; Paul W. Bossart, Minneapolis; E. S. Wallace, New York; P. C. Burns, Kokomo; J. G. Imsen, Pittsburg; A. F. Boardman, Boston; E. A. Katlin, Richmond; P. L. Spooner, Madison; E. B. Seeley, Philadelphia; Thos. McCoubray, New York; M. Kuhn, Philadelphia; J. D. Randall, Memphis; Frederick Harrington, Cleveland. The executive committee consists of J. E. Keelyn, J. R. Johnson and S. J Tunbridge. A constitution and by-laws were adopted and a plan of campaign determined upon. The meeting closed with enthusiasm in the prospects of success. About forty notices of membership were received. The next meeting will be at Niagara Falls, on Sept. 1.

Resuscitation from Electric Shock.

On Thursday evening of last week Mr. Frank Grover, foreman of the Rochester, N. Y., Gas & Electric Company, while standing near a 3,000-volt alternator, suddenly gave a loud cry and fell to the ground. Several of the men in the power house immediately ran to his assistance, and when they arrived on the spot he was unconscious and apparently dead. Very fortunately, Mr. Geo. A. Redman, manager of the company, had posted in the station copies of the instructions for resuscitation from electric shock, written by Dr. A. H. Goelet, and distributed to electric stations in poster form by THE ELECTRICAL WORLD, and several of the employees who had familiarized themselves with the details, immediately proceeded to apply the method, a doctor not arriving until a half-hour later. After laboring for three quarters of an hour signs of returning life were noticed, after which respiration returned slowly; the manipulations were kept up an hour, at the end of which time the patient was sufficiently recovered to be removed to his home.

The next day Mr. Grover was very weak from his terrible experience, his body was sore and his heart weak, but on the succeeding day he was able to move about out-doors. In relating his experience he said that he could not tell how the accident happened. All he remembers is that he was standing near one of the dynamos, and the next moment he lost consciousness; then he knew nothing until he awoke and found the doctor and the men working over him. When he returned to consciousness he did not have the slightest idea what had happened, and was intensely surprised when they told him that he had been subjected to a shock from 2,899 volts. He did not think that he leaned against the dynamo, as he had been an electrician too many years to do so foolhardy a thing, and concludes that he must have moved his arm in such a manner that it swept the brushes, thus coming in direct contact with the circuit.

Fatalities that Might Have Been Averted.

A correspondent in Harrisburg, Pa., sends us an account of two fatalities from electric shock which recently occurred there. An employee of a street railway while making some repairs, took hold of the trolley wire with one hand and grasped a span wire with the other, whereupon he received a violent shock and expired in a few minutes. It appears that the span wire was insulated only about three feet, the remainder being bare iron wire with the terminal wound around an iron pole

The second accident occurred to a man who attempted to adjust an arc light. He had been warned not to touch the lamp, but as he had been successful once before in making it burn under similar circumstances, he attempted it again and received a shock which resulted in instant death. Our correspondent expresses the opinion that the life of the former, and, perhaps, of the latter, might have been saved had an attempt at resuscitation been made according to the directions given by Dr. Goelet in THE ELECTRICAL WORLD of Sept. 8, 1894.

Dimensional Formulæ and the Theory of Units.

BY R. A FESSENDEN.

From Mr. Wolcott's article criticising my notes of May 4 and 18, on "Dimensional Formulæ," it would appear that we are at difference in very fundamental points. Mr. Wolcott holds:

1. That "the dimensions of the unit of any quantity have nothing to do with its physical nature, or even with its physical properties, if such it has, which are independent of those by which the unit is defined in the particular system." "Dimensional formulæ are largely optional."

2. That "the determination of the change of the magnitude of a derived unit, which results from changing the magnitude of one or more of the fundamental units, and allied uses, are the only legitimate uses to which dimensional formulæ can be put."

3. That the use of dimensional formulæ to "discover the ultimate constitution of matter and to solve other like questions regarding the fundamental physical properties of things," is not a correct one.

4. That we can have two different expressions for the dimensions of unit energy, each of which is correct.

My views on the subject, however, are:

That the dimensional formula of a quantity is a full and sufficient definition of the nature of that quantity, so far as it is possible for human knowledge to go, and that, consequently, *there is one and only one correct dimensional formula for any given quantity, and that if by any method we arrive at two different formulæ, one of them is incorrect.*

Consequently, I regard dimensional formulæ as a legitimate form of mathematical analysis.

I believe that the difference of opinion between Mr. Wolcott and myself is due to the fact that he has not perceived that I have, in my article, developed a new system of dimensions. On my part, I confess that I should have explained this more fully, but I was dealing with results rather than methods. The present system, in which we use only three fundamental units, *i. e.*, those of length, mass and time, is only capable of being correctly applied to gravitational phenomena. When it steps outside this it goes wrong, and is entirely incompetent to explain phenomena, or to be used correctly. So far I agree entirely with Mr. Wolcott, and the statements quoted above as embodying his views, are shared completely by the writer, so far as the C. G. S. system is concerned.

The C. G. S. system is based upon the entirely erroneous idea that (to quote from Clerk Maxwell's "Electricity and Magnetism," vol. 2, page 263) "every electromagnetic quantity may be defined with reference to the fundamental units of length, mass and time." That this idea was erroneous has been perceived, thanks, I believe, to the work of Prof. Rücker, and in the last edition of Everett's C. G. S. units, we find the modified statement, "*Nearly* all the quantities with which physical science deals can be expressed in terms of three fundamental units."

From Professor Rücker's work, we see that the number of fundamental units must be increased to five, *i. e.*, $L.$, $M.$, $T.$, μ and k.

I have, however, shown in my article of May 18, that the number of fundamental units must be still further increased to ten, when we come to treat of gravitated attraction and inertia separately.

These are:

1. L = dimensions of length.
2. T = dimensions of time.
3. q = dimensions of quantity of electricity.
4. b = dimensions of quantity of magnetism.
5. k = dimensions of specific inductive capacity.
6. μ = dimensions of permeability.
7. g = dimensions of quantity of gravity.
8. i = dimensions of quantity of inertia.
9. f = dimensions of property of medium, determining gravitation.
10. h = dimensions of property of medium, determining inertia.

This system gives us a means of expressing completely all the phenomena of nature fully, and in such a manner that we can use it as a means of investigation. When we know how electricity and gravity are related, then we can reduce these fundamental units from ten to three. These remaining three will be length, time and force. By force I do not mean electric force, or any particular force, such as gravitational force, but some function of the ether, by virtue of which one portion of the ether tends to move another. What its ultimate nature may be does not at present concern us, and it is possible that it never will.

It will be noticed that the quantities here symbolized by g, f and l, were given as a, l and m in my note of May 18. I have made the change in order to avoid conflict with the symbols recommended by the committee on notation of the last Congress.

It will be noted that the "fundamental" unit M has disappeared. The relations between electricity, magnetism, gravitation and inertia may be derived from the equations,

1.2.3. $-qq/L^2\ k = -bb/L^2\ \mu = gg/L^2\ f = ii/L^2\ h\ (= F.)$

4. $q/b = b\ k^{\frac{1}{2}}/\mu^{\frac{1}{2}}$

5. $k^{\frac{1}{2}}\ \mu^{\frac{1}{2}} = T/L$

6. $qb = FLT$

7. $f^{\frac{1}{2}}\ h^{\frac{1}{2}} = T/L$

8. $k/\mu^{\frac{1}{2}} = Z.$

Only one dimensional formula is possible for any one quantity.

Since by merely changing the dimensions of our units of length, time and force, we can make the numerical value of any quantity anything we please, except zero, it is evident that the numerical values are not of any importance in qualitative work, and that, so far as the nature of a phenomenon is concerned, the dimensional formulæ give us a sufficient means of investigation.

This method is a powerful one, in spite of its great simplicity. Take, for instance, equations A, B and C, of my article of May 18. Suppose one knowing nothing of electricity were asked what was the effect of a quantity of electricity on a quantity of magnetism. The symbols q and b appear together in equation C, and in equation 6 above, their product being equal to force multiplied by length divided by time. The right-hand side of the equation does not represent any one thing; but if we bring the T over to the left we have the right-hand side equal to work. Therefore, he would deduce the facts that if we have a quantity of magnetism, and a varying quantity of electricity, we have work, and that if we have a varying quantity of magnetism and a quantity of electricity, we again have work. The permeability or specific inductive capacity of the medium has no effect in either case. These results are Faraday's and Weber's laws.

Again, suppose that we wish to know if a moving quantity of matter exercises any other force on another moving quantity of matter, except that of gravitation. Multiplying the right-hand member of 6 by the right-hand member of 5, and similarly the left-hand members, we find that when we introduce the coefficients, k and μ, we have work and velocity, and since there is nothing else on that side of the equation, it must be the work which is propagated with the velocity. Taking the analogous equations concerning gravitation and inertia, we see that if gravitation is propagated with a finite velocity, then there will be an additional force.

One important fact is seen from the equations for q and b; that is, that though from the fact that the velocity of an electromagnetic disturbance is the same as that of light, it is almost certain that light is such a disturbance, it by no means follows that light is a wave motion. The supposition that this electromagnetic disturbance is a wave motion is based upon a similarity of form in certain sets of equations, but it is quite possible, though not probable, that other kinds of disturbance may give similar equations.

Having thus explained the method I have used, I would show how it answers Mr. Wolcott's objections. The latter asks, "Does Professor Fessenden seriously maintain that there are, or even that there ought to be, only 10^7 C. G. S. units in the ohm?"

To this I would reply, that that is my position. The equations which I have given in my article of May 18 show us, beyond any possibility of contradiction, that no matter what the true nature of electricity and magnetism may turn out to be, that the ohm has nothing to do with a velocity, and that it is really equal to work $\times$ time. In absolute units, therefore, it must be measured in erg-seconds, and as the second is also the practical unit of time, and there are 10^7 ergs in a joule, there are 10^7 = C. G. S. units in the ohm. No future discoveries as to the real nature of electricity can vitiate this conclusion.

In regard to Mr. Wolcott's difficulty concerning the two inconsistent expressions for work, I would say that the left-hand member of the equation, given by him, is not complete. The dimensions for gravitational attraction are not $M\ M/L^2$, but should be written $M\ M/L^2\ c$, where c is a constant depending on the medium. There is thus no inconsistency.

Mr. Wolcott's remarks upon my equations A and B (article of May 4) are based upon a misprint. Through an accident for which the writer is responsible, this article did not receive final revision before going to press, and the letter b was omitted from the right-hand member of the equation. If this be supplied, the method of obtaining the results will be seen.

The inconsistencies shown in the astronomical system given in Everett, and referred to by Mr. Wolcott, are due to the fact that the dimensions of one quantity have been omitted. Mass does not equal acceleration $\times$ distance; the right-hand term must also contain c. If this be supplied, the system, and with it its inconsistencies, disappear. In every case where inconsistencies appear, they will be found to arise from the fact that the equations have not been written out fully.

The system in which electrical and magnetic force have the same dimensions as other forces, given in my note of May 18, leads to the following definitions:

The resistance of a wire is the work done in forcing unit quantity of electricity through the wire, multiplied by the time taken in doing it. The unit of resistance is the erg-second, and the ohm = 1 joule-second.

The potential across the ends of a wire is the work done in carrying unit quantity of electricity from one end to the other. The absolute unit is the erg. The volt = 1 joule.

The current in a wire is the rate of flow of electricity in the wire. The absolute unit is the reciprocal of one second. The ampere = the absolute unit.

The capacity of a condenser is the reciprocal of the work necessary to charge it with two units of quantity. The absolute unit is the erg^{-1}. The Farad = joule^{-1}.

The inductance of a circuit is the energy stored up in the circuit magnetically, by the passage of a current, multiplied by the square of the rate of flow. The absolute unit is the erg-$(\text{second})^2$, and the Henry is 1 joule-$(\text{second})^2$.

It will be noticed that, while the practical units all remain the same as at present, the absolute units are changed. Instead of using 10^9, 10^8, and 10^7 as multiplying factors, we have now only one factor, *i. e.*, 10^7. This is a great gain in simplicity.

Mr. Heaviside has proposed to eliminate 4π from the circuital equations. It has been objected that it will reappear elsewhere. This is true, but it reappears in a place where it will not cause much trouble. So long as we have to use such things as Schwartzians to calculate the capacity of two parallel plates, the average electrician will be apt to let that branch of the science alone, in spite of the ample fulfillment of Lord Rayleigh's prediction that alternating currents would educate electricians to become mathematicians. If we must have a skeleton, it is better to keep it in the closet, among the electrostatic units.

If we follow Mr. Heaviside we get a new ampere and henry, each approximately 12 times the old; a new farad, 1-12 the old; a new volt three times as great, and a new ampere one third as great. Now, I believe nearly all these are in the right direction. The ohm is too small, our henry about right, our farad too large, our volt too small, while the new ampere would be just about the current taken by a single incandescent lamp. Taking this, therefore, in conjunction with the elimination of 4π, and the use of one multiplying factor, it would appear as if it would be a good thing if we could commence the twentieth century with these changes.

Curious English Laws.

Among the new proposed regulations in England there is a clause that no arc lamp shall be used in places where there is any danger of the presence of explosive dust or gas; according to this an arc light would not be allowed in any building where gas is used because wherever there is gas there is always a danger of the presence of an explosive gas. Our English contemporary, the *Electrician* stated that to be consistent there ought also to be a law that no building should have more than one gas jet, on the ground that the gas from one might be escaping and producing an explosive mixture which would be ignited by the other light. The parental English Board of Trade might do well to engage some assistance in framing their laws.

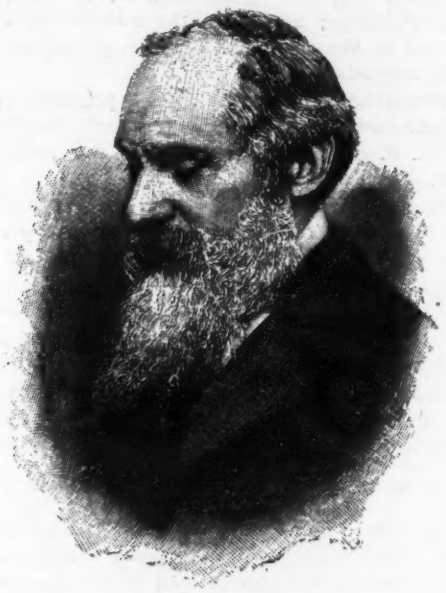
Carbide and Acetylene.

Our London contemporary, the *Electrician*, states that Mr. Wedding has found great differences between the acetylene yield of various samples of calcium carbide. One sample, from Pintsch's, gave 64.5 litres per kilogram; another gave 115.7; one from the Neuhausen works gave 96.8; one made by himself gave 254.3; while the theoretical is 348.

Lord Kelvin.

The July number of the *Pall Mall Gazette* contains an appreciative article on Lord Kelvin by Mr. Arthur Warren, from which we reproduce the accompanying portraits and the following paragraphs, relating more particularly to the personal history and traits of the great scientist.

After referring to the fact that Lord Kelvin has been for more than a half century the Professor of Natural History at the University of Glasgow, it is added that the University of Glasgow is assuredly Lord Kelvin's home; for he was but eight years old when he went to live there with his father, Dr. James Thomson, who had been appointed Professor of Mathematics. The elder Thomson was also a remarkable man. He was born on a little farm near Ballynahinch, in County Down, Ireland, where his family had dwelt for several generations, although their line was Scotch. James Thomson had, even as a lad, a huge hunger for knowledge. When he was between eleven and twelve years of age he learned, without the aid of a teacher and with the assistance of a few books, the principles of the sun-dial, and he taught himself to make dials for any latitude. Also, from old volumes which he somehow happened to unearth in his native village, he taught himself the elements of mathematics. His passion for this study seemed to be of such an extraordinary nature that his father permitted him to attend a small classical and mathematical school, in which, while still quite a youth, he became an assistant teacher. Teaching in this little school in the summers, he studied during the winters at the University of Glasgow, and at the end of his fifth year as a student there he received an appointment at Belfast, being afterward promoted to the position above mentioned.



LORD KELVIN.

We learn from this article that Lord Kelvin received his early education from his father, only going to school during the year previous to entry into the University of Glasgow. It was at the unusually early age of eleven years that he entered that university, and after taking the courses there he went to St. Peter's College, Cambridge, graduating in 1845 as Second Wrangler and First Smith's Prizeman. He was then immediately elected a Fellow of his College. Already as a student he had distinguished himself by his application to scientific pursuits and his interest in literature, and had been elected President of the Cambridge University Musical Society. After leaving Cambridge he went to Paris, where he worked for a while in the laboratory of the great physicist, Henri Victor Regnault. In 1846, being then only 22 years of age, he was appointed to the position which he still holds—the Professorship of Natural Philosophy at Glasgow University.

Lord Kelvin as a lad was an amazing prodigy, but he differed from nearly all juvenile prodigies that one reads of in his love of fun and boyish sports. He was as active physically as he was mentally, and he set himself up with a splendid stock of health. No doubt his elders thought him precocious. Imagine, if you can, the amazement of men grown gray in scientific work when they read in one of their favorite periodicals a series of learned papers which upset many old and well-nursed theories and substituted some surprising new ones which proved to be correct, and which were propounded by a youth of eighteen! Who was this William Thomson, whose contributions to the *Cambridge and Dublin Mathematical Journal* drew the attention of the scientific world? There was something more than juvenile audacity in his articles; there was knowledge—there was discovery.

Writing of the numerous and varied contributions to science and scientific literature of Lord Kelvin, Mr. Warren refers to his extraordinary capacity for turning from one task to another, as if he found inspiration in the change; yet all of his work is elaborate and painstaking to the last degree. Investigation must needs be accompanied by unbreakable precision, and this quality Lord Kelvin has to an astonishing degree.

He has an irrepressible habit of making notes, not because he distrusts his memory, but because he delights in working out complicated mathematical problems. Wherever he goes he carries in a coat-tail pocket a "little green book," in which, when not otherwise occupied, and not merely that his memory may be subsequently refreshed but that he may perhaps elucidate some theory which has engaged his mind, he jots down pages of mathematical demonstration which would be the despair of most men who are accounted clever in these lines. Thus, on railway journeys, or while driving in his carriage, or when waiting, perhaps, for some friend to make ready to accompany him on a drive or a walk, he will whip out the "little green book" and work with assiduous content. It is literally true that he is never idle except when he is asleep. But he is not a one-sided man. At a dinner, or a conversazione, he will be found readily engaging in any good talk that may be going on, and will amaze the listener by the extent of his information, and charm him no less by the wonderful clearness of his discourse than by the simple geniality of his manner.

The home of Lord Kelvin is described as a pleasant residence within the precincts of Glasgow University. It commands on three sides the most extensive views. The study, a good-sized room on the ground floor, has its walls covered from top to bottom with shelves filled with scientific books. Over the fireplace are hung some very rare and interesting engravings and photographs of Darwin and Joule and Faraday, and the cable-laying steamships the *Hooper* and the *Great Eastern*. Not only here, but throughout the house, there are evidences of Lord Kelvin's ingenuity. He has a simple, original, yet very effective ventilating system throughout the dwelling, and another original system for heating. His house, too, was the first one in the world to be completely lighted by electricity. He obtained the current from machines in the University laboratory,

LADY KELVIN.

and he carried it into every nook and corner of the house—into closets, cupboards, attics and cellars, as well as into the halls and sitting rooms.

Lord Kelvin is a most enthusiastic yachtsman, or was so when he could find time to indulge in his favorite recreation. It is characteristic of him that the older he grows the busier he becomes. For twenty years he went yachting every summer. Being a skillful navigator as well as a mathematician, a scientist, and an expert mechanic, he very naturally kept himself as busy aboard his yacht

as he did when ashore. But now he finds that he has not time to indulge himself in the pleasures of the sea, so he has sold his schooner, the *Lalla Rookh*, and whenever he can take what he calls a holiday, but what is only an opportunity for doing another kind of work, he goes to his country place, Netherhall, near Largs, in Argyleshire. Lord and Lady Kelvin made their wedding journey in the *Lalla Rookh*. Lady Kelvin is a charming woman, and a most devoted and wise companion and helper of her husband in all his labors. She is as much of an enthusiast for the sea as he is, and in the yachting days she used to accompany him on his cruises. So devoted to the sea was Lord Kelvin in these days, that he has, in the course of a cruise of seven months, spent but a single night on shore.

A painful accident befell Lord Kelvin more than thirty years ago, while at the favorite Scottish game of "curling," and left him permanently lame. Notwithstanding this, his physical activity is as remarkable as his mental energy. Mr. Warren gives an account of two specimen days which he had seen him live through. One Monday morning he returned to Glasgow from Edinburgh, where he had been staying for two or three days. He had no sooner reached home than he was at work in his study, attending to his correspondence with the aid of his secretary. After lunch he was absorbed in the intricate details of a plan for lighting a town by electricity. After that he joined Lady Kelvin in the drawing-room, and received friends for an hour or two. Then came dinner, which was followed till bedtime with elaborate calculations about the laws governing the formation of crystals. Lord Kelvin retires late and rises early. The next morning Mr. Warren met him before nine, and accompanied him to his lecture-room at the University, where he devoted an hour to expounding Kepler's laws before a crowded class. After that they drove to James White's, where Lord Kelvin made his final tests with his new electric meter; and from White's they returned to the University, where his lordship delivered, until one o'clock, a lecture on the Higher Mathematics. In the afternoon there was a consultation with electric experts, and the evening was similar to the previous one. The next day the untiring man took train for London, in order to preside over a meeting of the Royal Society.

Lord Kelvin is pronounced by the writer to be one of the most kindly-natured men he has ever known. His manner is very gentle and pleasant and winning, but for all that his utterance is decisive. As a teacher he is simply delightful, and is at the farthest removed from the grim professor. It is pronounced a great treat to hear him lecture, either before his University class, or before the Royal Society, or any other learned body. He speaks in a low conversational tone which is clear enough withal, and pleasantly Scotch in its accents, and a smile plays over his face as he delivers some difficult scientific truth. When he cracks a very hard philosophical nut he pauses for an instant, looks at his audience, gives a merry little laugh, as much as to say, "This is the simplest of pastimes, yet you appear to think, and the world thinks so too, that it is a difficult, even an insoluble problem. Now see how easy it is!" Then with a few words he clears the atmosphere, and his audience sees at once how simple it is to do a thing that one knows how to do. He talks very quickly at these demonstrations, as if there would never be time enough for him to say all that he has to say. Knowledge rolls from his lips in a swift flood. There is nothing rhetorical, there is no "talking for effect," and yet Lord Kelvin has hardly uttered a dozen words before you can see that he is master of his facts. He knows many things, and he knows them thoroughly. It is diverting to watch him turn swiftly on his heel, snatch up a piece of chalk, and demonstrate on the blackboard the very thing which he wishes to convey to his hearers. He seems almost to jump from his desk to the board, and then with a few white lines and cabalistic figures he flashes the laws of the universe at you. He has a way of putting things so that an attentive mind cannot forget them.

On a morning, says Mr. Warren, you will see him—a white-haired, white-bearded man of 70—walking across the University grounds toward the laboratory; in spite of his lameness he walks so quickly that his professor's gown streams out behind him. If you address him you will be charmed by the simple, natural courtesy of his response, and by the light of kindliness in his clear eyes. As he lifts his mortarboard cap you will note the height and fullness of his fine dome-shaped head, and you will feel instinctively, even if you are not aware of his identity, that you are standing in the presence of a great man, and a great-hearted one.

The Testing of Alternating-Current Dynamos.

BY H. BEHN-ESCHENBURG.

As is well known, that quantity which most surely determines the value and efficiency of an alternating-current dynamo is the fall of potential, *i. e.*, the difference in the potentials at the binding posts of the dynamo, 1°, when no current flows through the armature, and 2°, when the armature windings generate a current which has a definite difference of phase with the binding post potential, the revolutions and the current in the magnetizing field being constant in both cases. In other words, the fall of potential is the difference in the potentials (with constant excitation and revolutions) at no load and at a certain definite load. This fall of potential is determined essentially 1°, by the induction of the "current-carrying" armature windings on themselves; 2°, by the copper resistance of these windings; and 3°, by the reaction of the Foucault currents induced by the armature currents, principally in the massive iron field magnets.

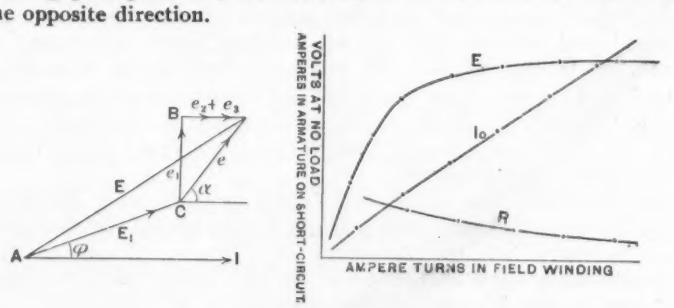
These determining factors of the fall of potential may be represented as electromotive forces, which, in definite phase, combine with the E. M. F. of the dynamo to form the resultant binding post potential.

We thus obtain three E. M. Fs. in the armature windings, proportional to the currents in the armature, which we place in a polar diagram (Fig. 1) according to their effective values and their phases (*i. e.*, their directions) and designate by e_1, e_2 and e_3.

In the same diagram, we let I represent the armature current (*i. e.*, the load current of the dynamo); E the E. M. F. of the dynamo, which is equal to the binding post potential at no load; and E_1, the binding post potential when loaded. The direction of the different quantities is determined by the angle of the phase difference which they have relatively to the current I. There will now naturally be a phase difference of $\frac{\pi}{2}$ between the E. M. F. e_1 of the self-induction and the current; and between the E. M. Fs. e_2 and e_3 and that of the current a phase difference of o. We assume further that for the chosen load of the dynamo, the phase difference between the binding post potential and the current is ϕ, where ϕ is defined by making the delivery in watts of the dynamo $W = E_1 I \cos \phi$.

For lighting distribution with transformers, ϕ is about 10° and $\cos \phi$ practically equal to 1; and for power distribution with non-synchronous motors ϕ may be taken as about 35° and $\cos \phi$ about 0.85.) The fall of potential of the dynamo, taken from the diagram, equals $E - E_1$.

For synchronous motors the same diagram is to be employed when the E. M. F. of the synchronous motor is greater than the binding post potential; if, however, $E - E_1$, e is to be drawn in the opposite direction.



FIGS. 1 AND 2.

The resultant e of the three E. M. Fs. e_1, e_2 and e_3, in a phase a relative to I, represents the total counter electromotive force of the "current-carrying" armature. By this E. M. F. e and the current I, and apparent resistance of the armature windings is defined as

$$R = \frac{e}{I}.$$

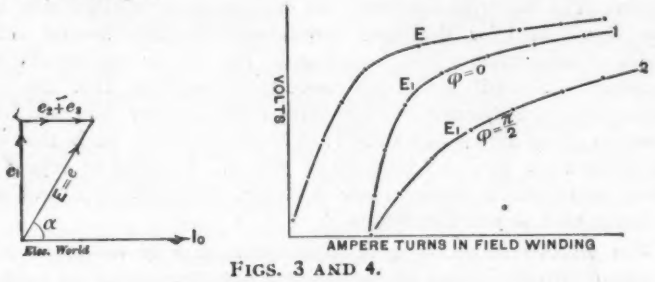
A chief problem in the testing of alternating-current dynamos is to ascertain and calculate in advance this resistance R and e, as when they are known, all quantities important for operating may be taken directly from the diagram Fig 1.

For this purpose I have for some time taken the following course, which I most heartily recommend to my colleagues. In the first place, there is drawn in the ordinary manner a characteristic of the E. M. F. of the dynamo when no current flows in the armature (compare Fig. 2, curve E). The abscissæ are the number of ampere-turns of the magnetizing continuous current (that is, the

strength of the exciting current), and the ordinates are the induced E. M. Fs. E of the dynamo, at a fixed number of revolutions. A second characteristic I_0 is taken after the armature windings have been short-circuited by an ammeter across their terminals. The abscissæ are again the number of ampere-turns of the field, and the ordinates are the current strengths of the short-circuited armature in amperes (designated by I_0). This curve I_0 as a rule differs but slightly from a straight line; with strong fields it is a little convex.

For the case of the short-circuited armature, the diagram, Fig. 1, is to be changed so that $E_1 = o$, $E = e$, and we then immediately obtain in Fig. 3, $e = E$ and $R = \frac{E}{I_0}$ for every value of the abscissæ.

This value of R we place as ordinates in Fig. 2 and so form a third characteristic R of the apparent resistance for every value of the field strength.



FIGS. 3 AND 4.

For any value of the load current I, with a fixed field excitation, $e = R\,I$ is given directly, and E_1, and ϕ may be calculated from the diagram. With a given field current, either E, ϕ and I are to be assumed as given and E_1 is to be determined in advance, or E, E_1 and I are given or observed and ϕ is to be determined from them. The following formulæ result from the oblique-angled triangle A, B, C of the diagram:

$$\cos(a - \phi) = \frac{E^2 - E_1^2 - e^2}{2\,E_1\,e};$$

$$E_1 = E - e\cos(a - \phi) - \tfrac{1}{2}\frac{[e\sin(a-\phi)]^2}{E}.$$

(The counter E. M. F. e should naturally be considerably smaller than E in practical cases.)

Finally, in order to ascertain the difference of phase a between e and I_0 or I, we must observe not only the current I_0 with short-circuited armature, but also the watts consumed, $E\,I_0\cos a$, either directly by means of a wattmeter, or by measuring the expenditure of energy necessary to drive the short-circuited dynamo; this last may be done by observing the watts used by a continuous-current motor employed to drive the alternator. With good dynamo machines, a is greater than 80°, and for approximate measurements may be put equal to $\frac{\pi}{2}$. This means that the copper losses and the losses through Foucault currents should be very small compared with the losses in potential. The component e_2 of the E. M. F. e, is easily determined by means of resistance measurements, for if r be the armature resistance, $e_2 = I\,r$.

The component e_3 increases approximately with the square of the number of revolutions, and so can be separated from e_2. As a check, a can be calculated when measurements with the dynamo loaded have given observed values of

E_1, E, I and ϕ; for instance, when $\phi = o$ or $\phi = \frac{\pi}{2}$ with wholly inductionless or purely inductive load, respectively, or when ϕ is determined by means of a wattmeter.

(It is to be remarked, that for small values of ϕ, for instance, with transformers, the diagram will give much more accurate determinations than a wattmeter, for from the diagrams in ϕ and from the wattmeter $\cos\phi$ is read.)

If, as an approximation we make $a = 90°$, the formulæ for ϕ and E_1 will become simplified, as follows:

$$\sin\phi = \frac{E^2 - E_1^2 - e^2}{2\,E_1\,e};$$

$$E_1 = E - e\sin\phi - \frac{e^2\cos^2\phi}{2\,E};$$

and for the limiting cases of inductionless and purely inductive load:

$$\phi = 0\ ;\ E_1^2 = E^2 - e^2.$$
$$\phi = 90°;\ E_1 = E - e.$$

The two characteristics E and I_0 may be taken in a very short time with a voltmeter, a continuous-current ammeter, a revolution counter and an alternating-current ammeter. The driving of the dynamo requires in this case only 10 to 20 per cent. of the normal load; *i. e.*, the energy loss of the loaded dynamo.

The short-circuit current I_0, during the short time which is necessary for the observation, may be raised, without hesitation, to two or three times the normal current. When taking the short-circuit curve I_0, the number of revolutions are of small importance, for with a fixed field magnetization, the short-circuit current will naturally remain constant at all speeds.

In the curve diagram, Fig. 4, are drawn the special characteristic curves of the binding post potential E_1, calculated from Figs. 1 and 2, which correspond to the dynamo load when carrying a current I in the two limiting cases $\phi = o$ and $\phi = 90°$, for all field excitations and $a = \frac{\pi}{2}$. These are the curves 1 and 2, between which, for all possible values of ϕ, must be the binding post potentials of the dynamo with the current I.

Besides the quantity R, determining the efficiency of the dynamo, this method gives a clear picture of the leakage conditions of the machine. The ampere-turns of the "current-carrying" armature windings must act inductively on the same magnetic circuit; the lines of force which are induced by one of these windings without cutting the turns of the other, are designated as scattered lines.

We will assume that $100 \times S_1$ per cent. of the total lines induced by the field winding and $100 \times S_2$ per cent. of the total lines of the armature winding are scattered and so lost for useful inductive working.

Let the number of turns of the field be w_1, and of the armature w_2, in which both numbers are to be reduced to the same magnetic circuit. This reduction is easily accomplished by the help of a schematic drawing, in which the magnetic circuit, that is, the closed courses of the magnetic lines of force in the dynamo, are drawn as linear conducting circuits, in analogy to the diagram for branching electric currents, and the ampere-turns of the armature and the field, at the places where the windings are cut by the circuit of the lines of force, are designated as magnetomotive forces, analogously to electromotive forces. The number of lines of force, in analogy to a current strength is calculated for every part of the circuit according to Kirchhoff's rules for divided currents. For the short circuit, equality must obtain between the magnetomotive forces of the armature current and the field current, as far as the ampere-turns which occasion the scattered induction and those which induce the E. M Fs. e_2 and e_3. These equal ones are the magnetomotive forces which induce the E. M. Fs. E and e_1.

We thus obtain the important condition:

$$(1 - S_1)\,i_0\,w_1 = \frac{1.4\,(1 + S_2)\,I_0\,w_2}{\sin a}$$

in which i_0 is the continuous field current, and the factor 1.4 in the right member the amplitude of the mean value of I_0.

If the field system possess a single magnetizing coil, w_1, as is easily seen, must be multiplied by half the number of poles; and if the armature system consist of N phase divisions, w_2, in the right hand member, is to be multiplied by $\frac{N}{2}$, and w_2 signifies the number of turns of one phase division.

From this equation, which besides the number of turns presupposes only the observation of the curve I_0, we obtain for every excitation of field, the value of the loss of potential in per cent.; that is, the value of the ratio of the counter E. M. F. e to the E. M. F. E_1 of the dynamo with a load current I:

$$\frac{e}{E} = \frac{I}{I}\text{; or, also, } \frac{e}{E} = \frac{I\,w_2}{i_0\,w_1}\cdot\frac{1.4\,(1 + S_2)}{(1 - S_1)\sin a}.$$

That is to say, e has the same ratio to E as the load current has to the short-circuit current, with constant excitation; or as the number of ampere-turns of the armature to those of the field, multiplied by a factor approximately equal to 1.4. This factor is:

$$\frac{1.4\,(1 + S_2)}{(1 - S_1)\sin a} = \frac{i_0\,w_1}{I_0\,w_2}.$$

The leakage value S_1 is, on the other hand, easy to calculate when the principal dimensions are known, so that the preceding formula will give the value of S_2, which is difficult to calculate. The total magnetic resistance ρ of the magnetic circuit of the field and armature windings is calculated in the usual manner from the

individual resistances of the air gaps and the iron parts at the chosen saturations.

If we designate the total number of lines induced by the ampere turns of the field by $\mathfrak{G}$, and the number of alternations of the dynamo by n, the well-known equations obtain:

$$E = \frac{\mathfrak{G} \cdot w_2 \cdot 2\pi n 4\pi}{1.4 \times 10^8 \quad 10} i_0 w_1 = \mathfrak{G} \rho (1 + S_1).$$

Also,
$$1 + S_1 = \frac{5.6\, i_0 w_1 w_2 n}{E \rho 10^8}.$$

On the other hand, in the case of the short circuit:

$$I_0 R = E, \text{ and } R = \frac{8 w_2^2 n (1 + S_2)}{\rho (1 + S_1)(1 - S_1) \sin a. 10^8}.$$

This last equation shows us the constructive meaning of the apparent resistance R of the dynamo. R increases proportionally to n, and with the square of the number of turns.

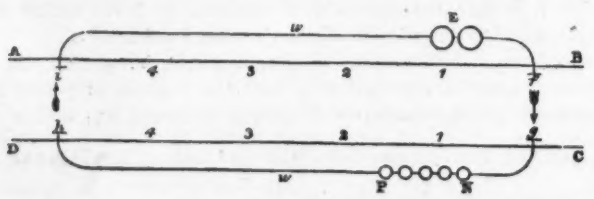
By means of this sketch I believe that I have shown a very convenient method, which I have myself tested in a number of practical cases, giving direct values which make possible an exact and unobjectionable comparison and discussion of alternators. Knowing the characteristics for no load and for short circuit, the limits of the loading of every dynamo for a prescribed binding post potential can be determined beforehand; that is, the values of the current strength and of the shifting of phase between the current and the binding post potential.

Three months ago I sent a theoretical and more complete discussion of this method in manuscript, to the Berlin *Elektrotechnische Zeitschrift*.

Mode of Crossing Broad Rivers or Other Bodies of Water Without Wires.

The recent experiments of Mr. W. H. Preece, in England, on telegraphing without wires, recall the work of Morse in the same direction, an account of which is contained under the above caption in Alfred Vail's "American Electromagnetic Telegraph," published in 1845. In a letter to the Secretary of the Treasury, and by him submitted to the House of Representatives, Dec. 23, 1844, Morse referred to the subject as follows:

"In the autumn of 1842, at the request of the American Institute, I undertook to give the public in New York a demonstration of the practicability of my telegraph, by connecting Governor's Island with Castle Garden, a distance of a mile; and for this purpose I laid my wires, properly insulated, beneath the water. I had scarcely begun to operate and had received but two or three characters, when my intentions were frustrated by the accidental destruction of a part of my conductors by a vessel, which drew them up on her anchor, and cut them off. In the moments of mortification, I immediately devised a plan for avoiding such an accident in future, by so arranging my wires along the banks of the river as to cause



Arrangement of Circuits.

the water itself to conduct the electricity across. The experiment, however, was deferred till I arrived in Washington; and on Dec. 16, 1842, I tested my arrangement across the canal, and with success. The simple fact was then ascertained that electricity could be made to cross a river without other conductors than the water itself; but it was not until the last autumn that I had the leisure to make a series of experiments to ascertain the law of its passage.

"The accompanying diagram will serve to explain the experiment. *A*, *B*, *C*, *D*, are the banks of the river; *N*, *P*, are the battery; *E*, is the electromagnet; *w*, *w*, are the wires along the banks, connecting with the copper plates, *f*, *g*, *h*, *i*, which are placed in the water. When this arrangement is complete, the electricity, generated by the battery, passes from the positive pole, *P*, to the plate, *h*, across the river through the water to plate *i*, and thence around the coil of the magnet, *E*, to plate *f*, across the river again to plate *g*, and thence to the other pole of the battery, *N*. The numbers 1, 2, 3, 4, indicate the distance along the bank measured by the number of times of the distance across the river. The distance across the canal is 80 feet."

A table is included giving the deflection of a galvanometer with different battery power and size of plates, and the experiments are declared to show that "electricity crosses the river, and in quantity in proportion to the size of the plates in the water. The distance of the plates on the same side of the river from each other also effects the result. Having ascertained the general fact, I was desirous of discovering the best practical distance at which to place my copper plates, and not having the leisure myself, I requested my friend, Prof. Gale, to make the experiments for me. I subjoin his letter and the results."

The letter from Prof. Gale dated New York, Nov. 5, 1844, is as follows:

"I send you herewith a copy of a series of results, obtained with four different sized plates, as conductors to be used in crossing rivers. The batteries used were six cups of your smallest size, and one liquid used for the same throughout. I made several other series of experiments, but these I most rely on for uniformity and accuracy. You will see, from inspecting the table, that the distance along the shores should be three times greater than that from shore to shore across the stream; at least, that four times the distance does not give any increase of power. I intend to repeat all these experiments under more favorable circumstances, and will communicate to you the results."

The tables referred to give deflections of a galvanometer with plates of different sizes and for different distances along the bank.

Morse says in conclusion, that "as the result of these experiments, it would seem there may be situations in which the arrangements I have made for passing electricity across the rivers may be useful, although experience alone can determine whether lofty spars on which the wires may be suspended, erected in the rivers, may not be deemed the most practical. The experiments made were for but a short distance; in which, however, the principle was fully proved to be correct. It has been applied under the direction of my able assistants, Messrs. Vail and Rogers, across the Susquehanna River, at Havre-de-Grace, with complete success—a distance of nearly a mile."

One More Evidence of Returning Prosperity.

It is not alone in increased wages and in the growing volume of business that we notice the turn of the tide. There are other indications that are equally convincing. A manufacturing firm which had the misfortune some months ago to be caught in the financial panic, but which had also the strength and courage to fight its way through, has just sent The Electrical World a check for $100, but dated January 24, 1895. The check was accompanied by the following explanatory note:

"We enclose herewith our check for $100. You will notice that this check is dated way back into antiquity. It also bears with it quite a history. When the check was made out to your order last January, with the intention of making payment on account of our advertisement, this company was right in the midst of those stormy days that many corporations encounter on some occasions in their career. It occurred to the writer that he might better hold the check over for a day or two and await developments which were pending at that time. After the lapse of a few days he found out that the crisis had come, and the fight was on, and it was a good thing that the check had not been forwarded. However, it is sent you herewith, and the writer is pleased to add that the company has successfully stormed the fort."

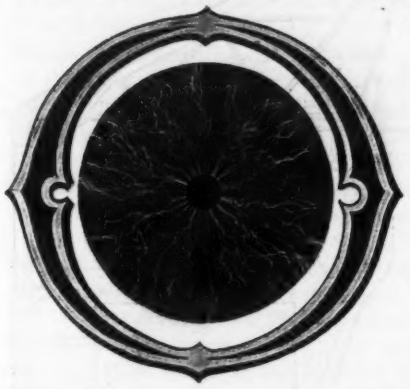
We congratulate our friends upon the return of brighter days, and trust that the publication of their experience will have the effect of encouraging others who have not fully recovered from the effects of the recent financial storm.

Progress Abroad.

The progress of the electrical industry in Europe is well indicated by the output of the large Swiss factory at Oerlikon. The number of dynamos made by this firm up to the end of May is 3,318, many of which are very large machines; the number of transformers is 1,843; more than half of these dynamos and transformers were made during the last two years; during that time 69 traveling cranes were constructed, representing a total lifting power of 1,600,000 pounds.

The Westinghouse Electric & Manufacturing Company's New Plant—II.

POWER PLANT AND TWO-PHASE SYSTEM OF CURRENT DISTRIBUTION.



F all the branches of electricity, that dealing with polyphased currents offers by far the greatest interest at the present time, and this is true whether we consider the immense field offered for the utilization of the polyphased principle, or the beautiful flexibility and simplicity of its application.

As compared with either the direct or simple alternating current, the polyphase system has important advantages. Direct currents, although available for most uses to which electricity may be put, have a limited range in the transmission of energy because of the comparatively low voltage necessitated by the use of a commutator. The simple alternating current, by reason of the fact that it can be easily and efficiently transformed from a high to a low voltage, or vice versa, furnishes the ideal means for transmitting power over long distances. Unfortunately, however, while the power thus transmi ted is available for lighting, a difficulty is offered to its utilization for power purposes from the fact that the so-called single-phase motor will not start with load and will not run at varying speed.

Polyphase currents combine the advantages lacking in both the others; they can be used for long-distance transmission, since they can be easily converted by transformers up to any desired voltage, the same as the simple alternating current; and they are available for the operation of self-starting motors requiring large starting torque or variations in speed. Where a direct current is necessary for electrolytic work, etc., it may be obtained from a polyphase circuit by means of rotary transformers. Thus directly, or through the use of transformers, polyphase currents meet every known requirement of electrical energy. The only objection that can be urged against their universal adoption is, that they require more than two wires for conveying the energy.

As a simple exposition of the principles of polyphase currents may have an interest to some of our readers, and enable them to follow more satisfactorily the account of their practical application herein given, we print in another column an article in which the subject is briefly treated in an elementary manner, and with especial reference to induction motors.

The Westinghouse Company holds a series of 29 American patents on the polyphase system of alternating currents, issued between May 1, 1888, and Dec. 8, 1891, to Nikola Tesla. The first large installation of apparatus operated under this system was made at the World's Fair. Since that time many other installations have been made, chief of which is the Niagara plant, now the centre of so much interest, inquiry and investigation.

Power Plant.—The Westinghouse Company is convinced that the most economical method of distributing power through mills, factories, etc., is by the use of electricity, and as it also believes in the superiority of polyphase currents for work of this kind, it was so arranged that all the machinery in its new factory should be operated in accordance with this latest prac ice.

The power plant at East Pittsburg is a fine example of the latest developments in steam and electrical engineering, as well as of the most modern and economical methods of power generation and distribution. The plant is almost identical with one that might be used for the supply of high-potential long-distance transmission circuits. As all the energy generated at this plant is used within a few hundred yards of the station, the potential is restricted to only a few hundred volts.

On account of the nearness of the points of distribution, polyphase currents have no advantages over the direct current in the way of transmission and distribution, but their superiority is quickly apparent when the simplicity and ease of handling the generators and motors is considered. A comparison, for example, of the direct and polyphase generators in the power house illustrates the point in question. Though the direct-current machines are of the most improved type, their commutators of necessity have daily required a certain amount of attention, while the polyphase machines have needed hardly a half hour's care since they began operating some five or six months ago. Again, the motors require no starting box or controller when starting, as they are entirely self contained, and it is only necessary to throw the short-circuit switch after they have gotten under way, in order to have them take up and carry their regular loads. The absence of commutators and starting boxes obviously make the polyphase motors in every way preferable to direct-current machines for use by the average workman.

One of the novel features in the operation of the East Pittsburg plant is the coupling of direct-connected alternators in multiple. Though in some few cases, both in this country and abroad, belt-driven machines have been run in parallel, the present installation is one of the first instances where high-speed engines directly

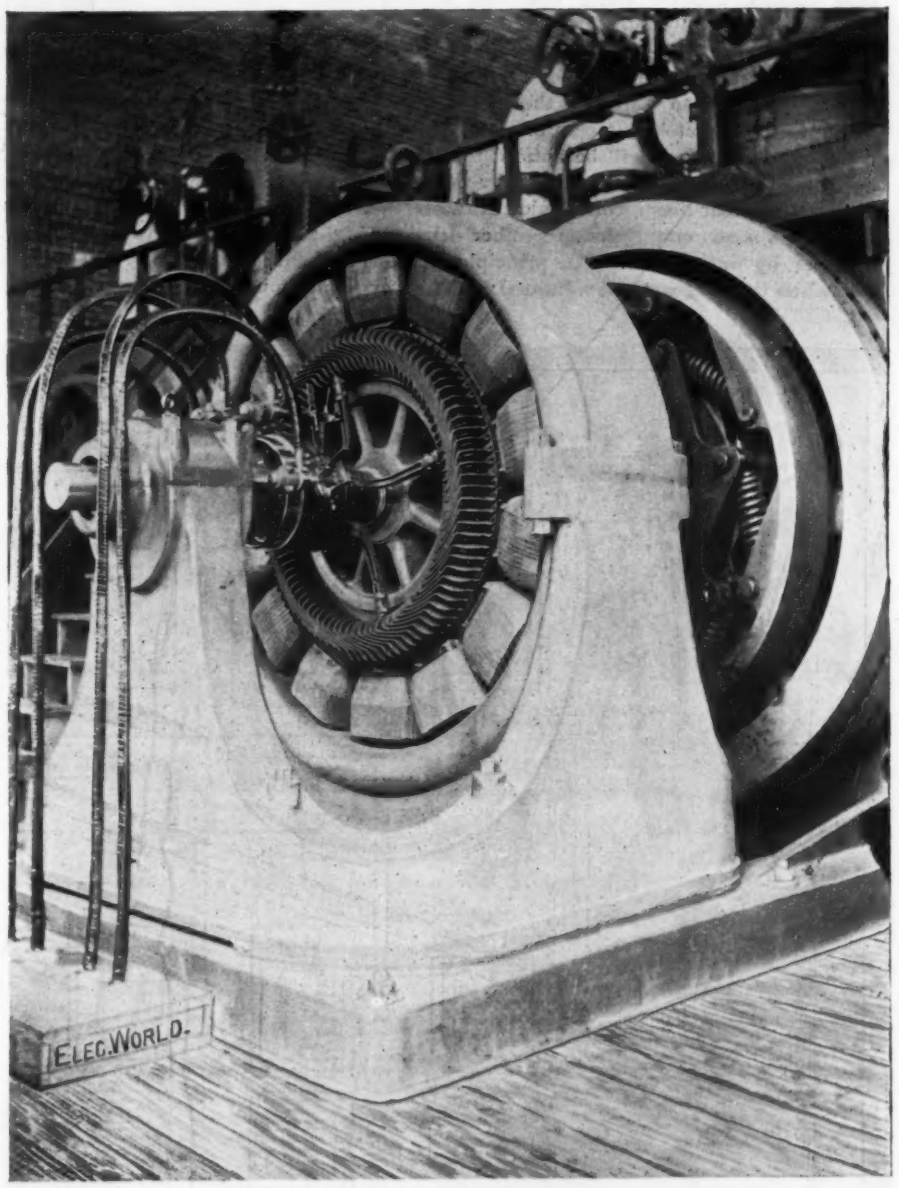


FIG. 1.—500-HP DIRECT-CONNECTED TWO-PHASE GENERATOR.

coupled to slow speed alternating-current machines have been so operated. For central station work this feature is one of much importance, as heretofore alternating-current practice has tended almost entirely to the operation of generators separately. Though many electrical engineers have for some time advocated the multiple arcing of alternators, there has thus far been a marked conservatism on the part of the central station manager in regard to such methods. A glance at the very satisfactory way in which the polyphase machines at East Pittsburg are operating would demonstrate to the most sceptical that the running of alternators in multiple is in every way a commercial success. In a few weeks, we shall, no doubt, have further proof, on a large scale, of the practicability of paralleling alternators, as the huge generators at Niagara Falls are to be operated on this plan.

Power House.—The power house is a fine example of modern design and adaptation to requirements; it is 206 feet in length by 76 feet wide, and open to the ridge of the trussed roof 62 feet above the floor. The building is of brick, resting on 16-foot stone foundations laid in concrete. All beams, girders, etc., are iron, and the roof of slate, so the building is completely fireproof.

Boiler Room.—At present there are installed five batteries each of 500 horse-power, Pierpoint vertical water tube boilers, located along one side of the boiler house as shown in Fig. 3. Directly opposite, there is provided space for a similar installation, for which there is already beginning to be a need. Fig. 2 gives a cross-section through the boiler house and shows very completely the plan of construction of the boilers. From this it will be noticed that the boilers have three upper drums connecting by means of tubes to three lower drums. The rear drum communicates with the forward ones by means of a steam connection, the other drums being all connected together by water tubes. The principle of the Pierpoint boiler is that when the feed-water is admitted to the lower rear or mud drum, it is warmed sufficiently in its ascent to the upper rear drum to deposit its sediment and impurities in the former. From there the water is distributed to the tubes and other drums where the steam is generated.

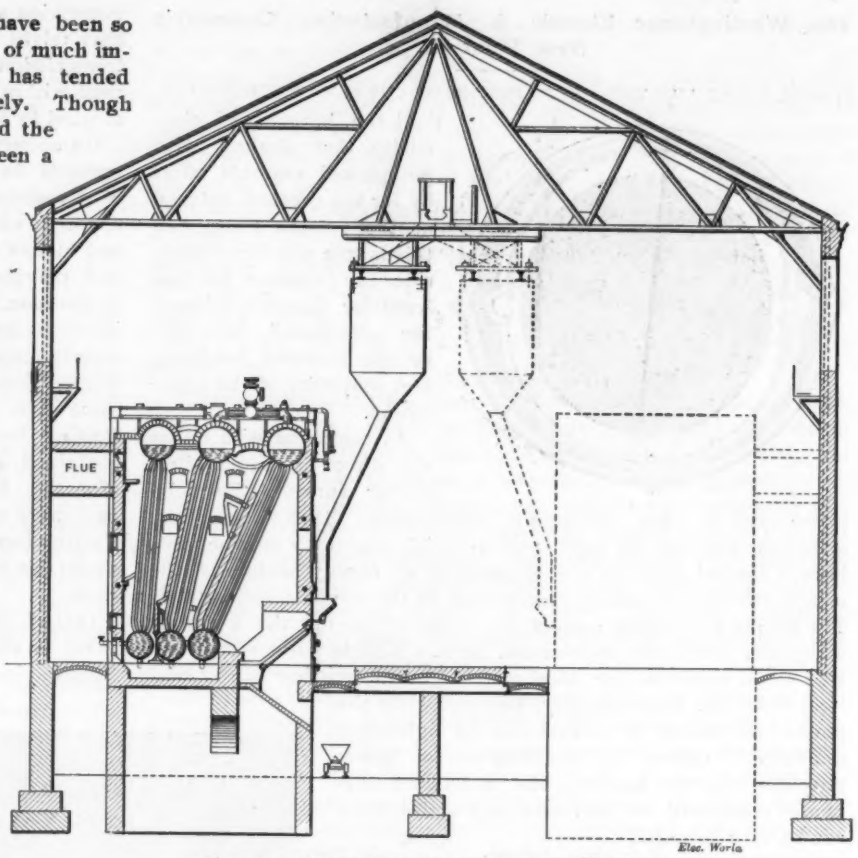


Fig. 2.—Cross-Section of Power House.

The boilers each occupy a space 18 feet 10 inches square and 22 feet 7¾ inches in height. There are 321 three and a half inch

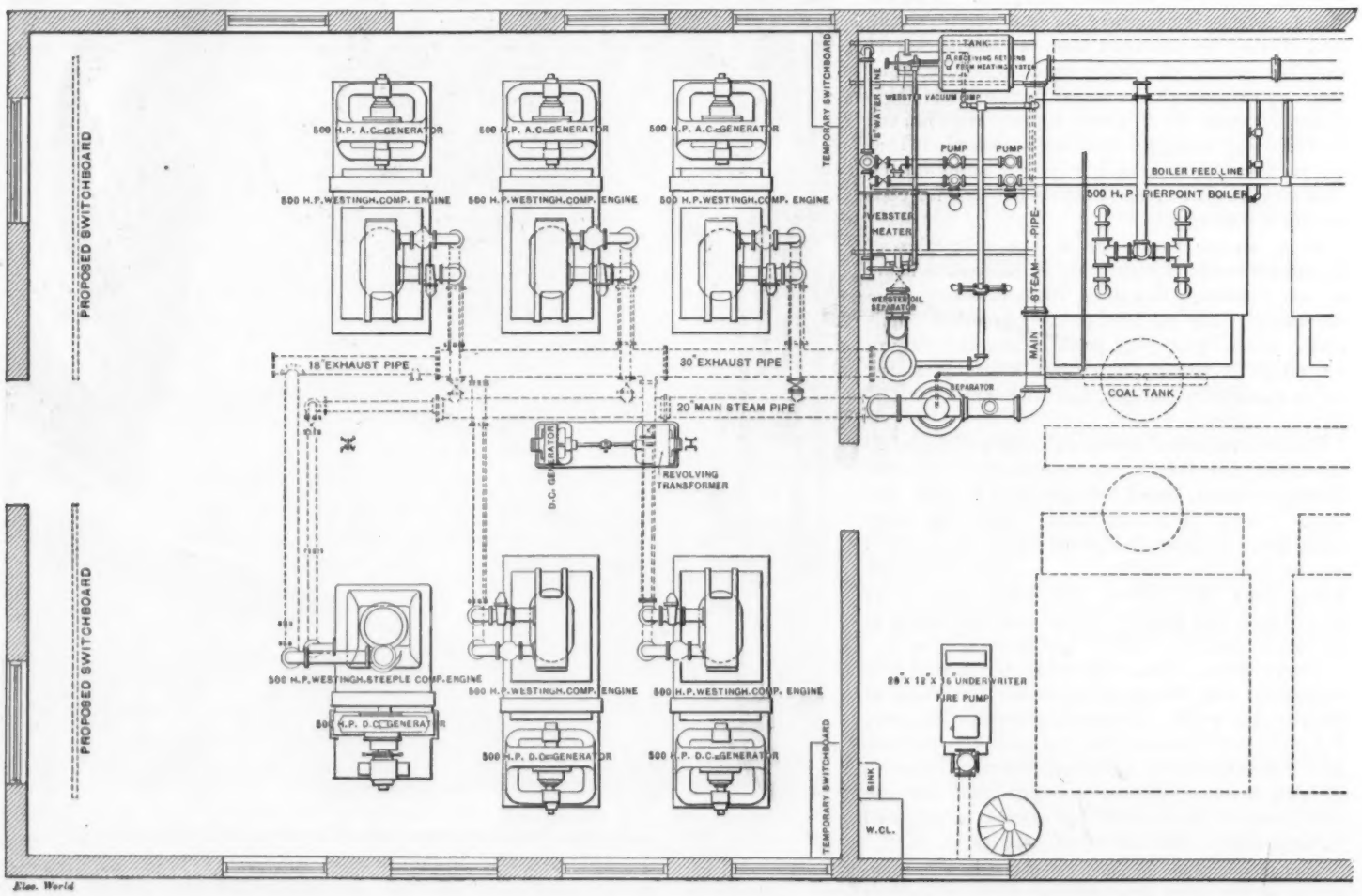


Fig. 3.—Ground Plan

tubes connecting the various drums. The three bottom drums are 30 inches in diameter, the two forward top drums 42 inches in diameter, and the rear one 36 inches in diameter.

Steam is generated at 130 pounds pressure, and is delivered through wrought-iron feeders equipped with Pratt & Cady valves, to a 20-inch main which runs along the west wall of the boiler house. The main passes into a 20-inch Stratton steam separator of the type shown in Fig. 9, which was supplied by the Goubert Manufacturing Company of New York, and is perhaps the largest separator ever made for low-pressure steam; the pipe then dips below the floor and passes up on the other side of the fire wall to the distributing pipes supplying the engines. The mains and steam pipes are all supported by roller bearings.

The boilers are each fired by two Roney automatic stokers, (Fig. 8), fed with coal from cylindrical iron tanks suspended, as shown in Fig. 7, from the roof trusses. The stokers are all driven by a single Westinghouse standard five-horse-power engine, as shown in Fig. 7. The grates of the stoker form a series of steps, to which the coal is fed from the dead plate by a pusher having a vibratory motion; each step of the grates is given a rocking motion, the grate surface thus alternately forming a series of steps and an inclined plane with the grates partly overlapping like the shingles of a roof. In this manner the fuel is worked down and at the same time broken up. The rocking motion is from 7 to 10 strokes per minute.

The ashes from the grate bars drop into large hoppers below the boilers and are thence delivered to cars on a track in the tunnel below the floor of the boiler house. These arrangements will be clearly understood from Fig. 3. At the end of the tunnel is an elevator for lifting the cars to the surface, where they are run to the dump and the ashes used for filling in.

Smoke connection from the boilers to the stack is made through a 72 by 40-inch brick flue running the length of the building, back of the boilers. The smoke-pipe is of iron and was erected by Riter & Connoly of Pittsburg. It is of the self-sustaining type, 198 feet in height with a 10-foot core, brick lined to the top, the whole supported on a brick base. As soon as additional boilers are installed, there will be erected a companion chimney.

Coal is brought to the power house by means of an elevated railway

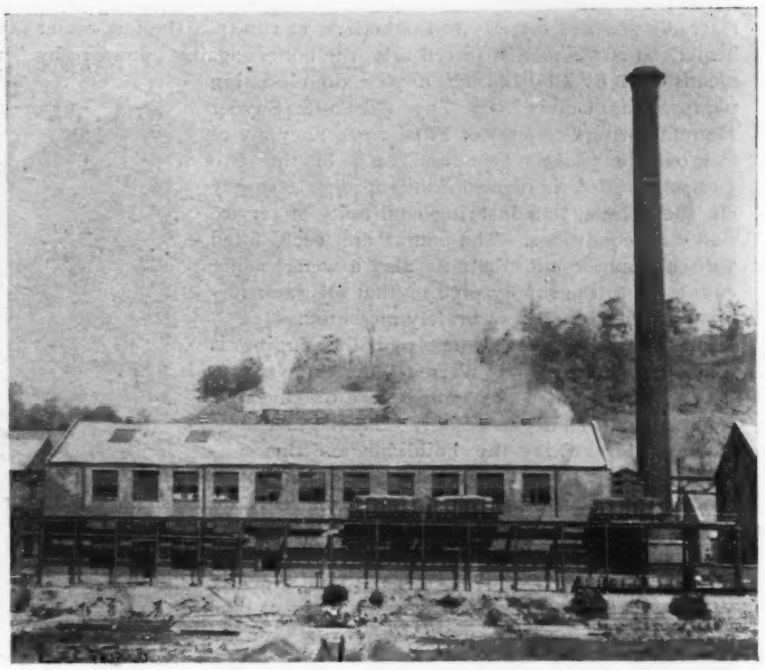
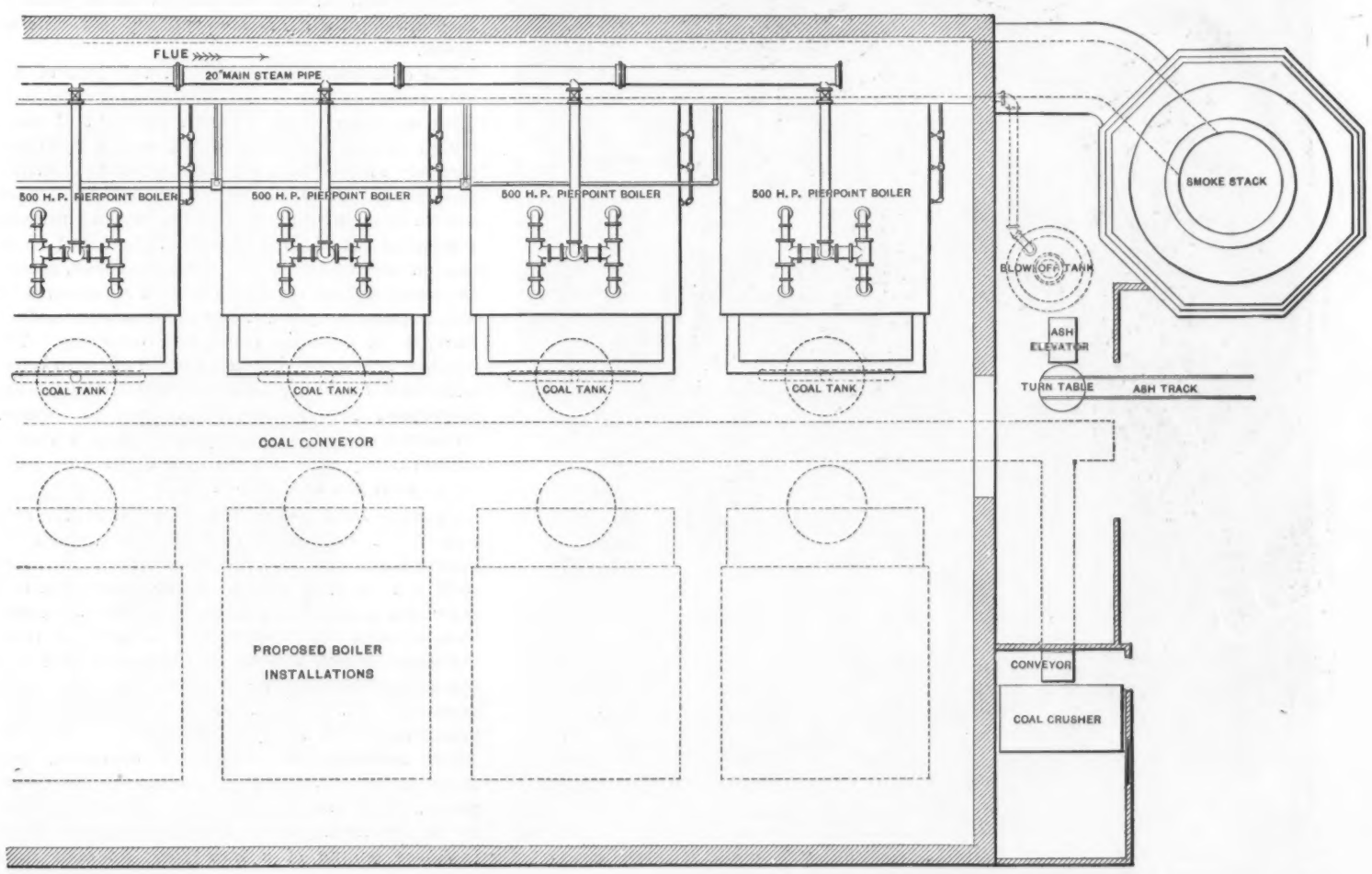


FIG. 4.—POWER HOUSE.

track (Fig. 4), from which it is dropped through a chute into bins located at the east end of the power house. On its way to the bins the coal passes through a crusher if necessary. From the bins the fuel is hoisted 60 feet by means of a chain bucket elevator, which empties it into a conveyor that carries it to the tanks feeding the stokers. The capacity of each of these tanks is 8 tons, and the total capacity of the bins about 150 tons. A 15-hp electric motor drives the conveyor and a 20-hp motor operates the lift and runs the crusher when required. The coal apparatus was all installed by Heyl & Patterson of Pittsburg.

It is so arranged that feed-water for the boilers may be fed under



OF POWER HOUSE.

reservoir pressure directly to the boilers, or run into the feed-water heater, from which it is forced into the boilers against pressure by means of 12 by 7 by 18-inch duplex double-acting pumps, manufactured by The Wilson & Snyder Manufacturing Company of Pittsburg. They are of the outside packed type and each of the two pumps installed is of sufficient capacity to supply all the boilers, thus insuring continuity of service under all conditions. The pumps are each fitted with a counter and there is also a water meter connected to the supply pipe so that all water furnished the boilers is accurately measured.

Part of the exhaust steam from the engine is used for supplying a Warren-Webster vacuum heater, which raises the temperature of the feed water to 200–210 degrees Fahr. Exhaust steam is also used for heating the buildings and the condensed water from the radiators and heaters is returned to an elevated tank near the eaves of the boiler house by means of a Warren-Webster vacuum pump, which maintains from 10 to 15 inches vacuum on the heating system, thus relieving any back pressure on the engines. From the elevated tank the water flows by gravity into the feed-water heater, where the level is maintained by a float. When the returns of the heating system are insufficient to supply the demands, the float automatically admits cold water. The above system of vacuum heating, known as the Williams system, was installed by Warren, Webster & Company, of Camden, N. J.

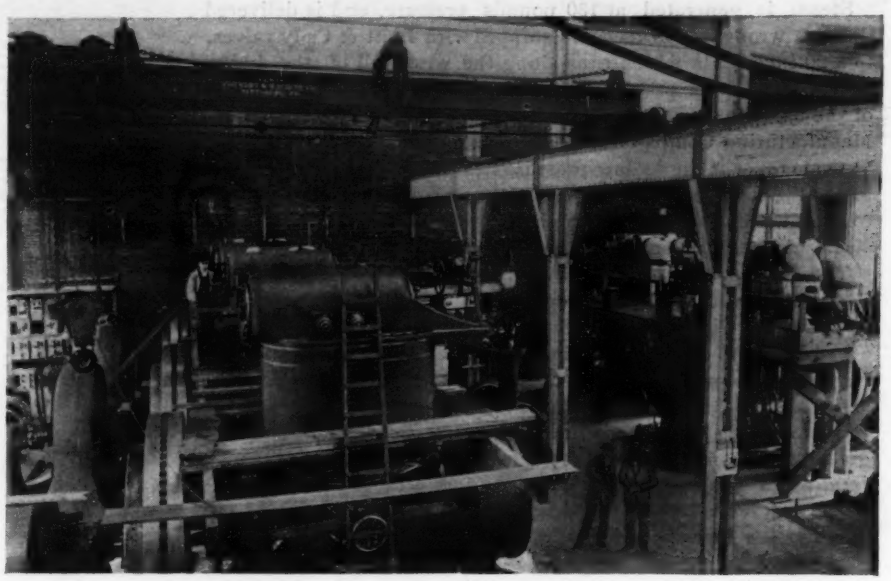


Fig. 5.—Interior of Dynamo Room.

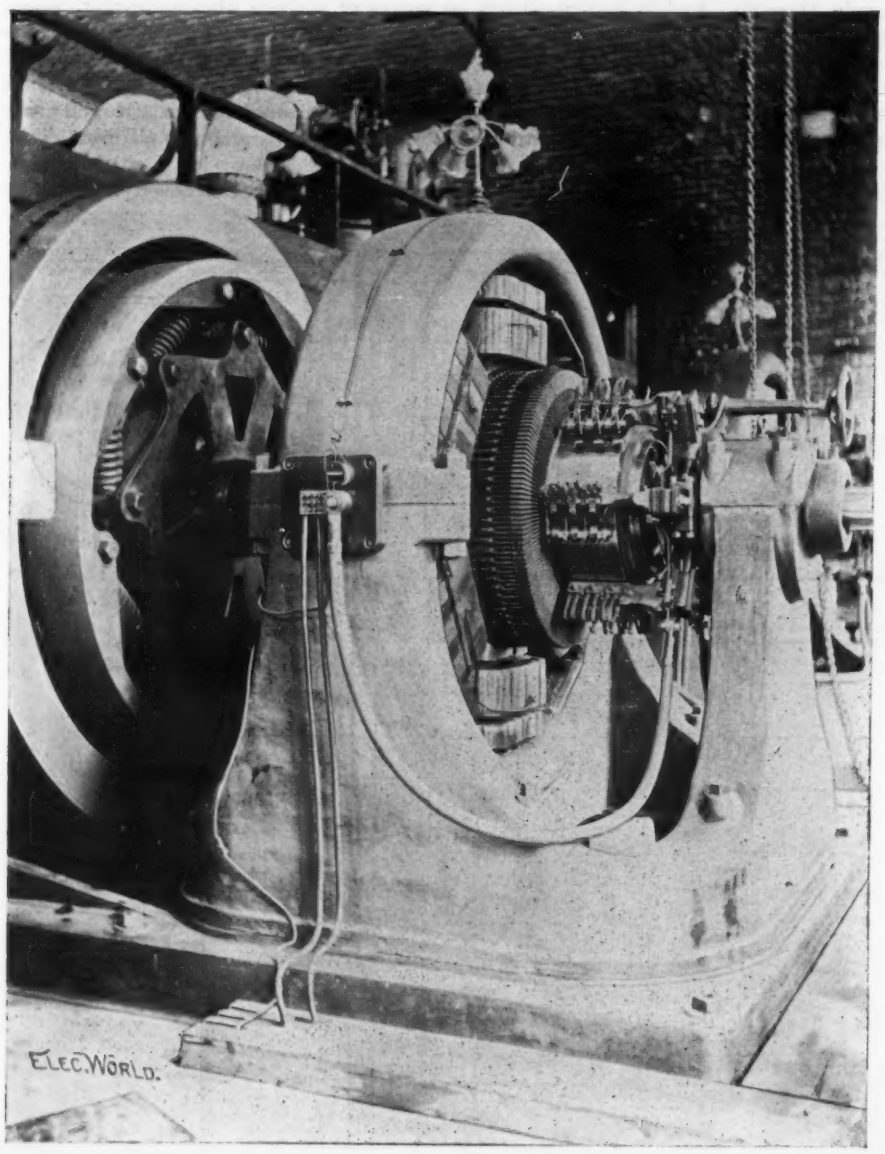


Fig. 6.—500-hp Direct-Connected D. C. Generator.

There is also being put in the boiler house a 20 by 12 by 16 inch Snow underwriters' high-pressure fire pump, which is to obtain its supply of water either from the city mains or from a large reservoir recently sunk just outside the power house. Furthermore, there are in the boiler room several Westinghouse air pumps for maintaining air pressure used in the manufacturing departments, and also two Webster grease separators, as well as other minor but necessary apparatus.

Engines.—The five engines already in operation are of the regulation Westinghouse compound type illustrated in Fig. 10. As shown in the power house floor plan, the high and low pressure cylinders are arranged side by side, and are of 23 and 40 inches diameter respectively, having a 20-inch stroke. When running at regulation speed of 215 revolutions per minute, with 125 pounds steam pressure, they develop their full rated capacity of 500 horsepower.

The distinguishing features of this type of engine are almost too well known to need repetition. They are distinctively a "high speed" and not a "high speeded" engine, which makes them particularly adapted for direct connection to electrical generators. They are equipped with what are known as momentum governors, which instantly respond to the slightest changes in load and maintain an engine speed that is constant from second to second and not merely an average speed per minute, a point of great importance where sudden changes in load are constantly occurring. The engines are made single acting in order to better withstand the wear and tear which the modern high-speed engines are called upon to endure. By reason of their being upright, they occupy a comparatively small space, and all working parts are incased and kept bathed in oil.

Dynamo Room.—The dynamo room at the west end of the building is 76 by 70 feet, and completely separated from the boiler room by an 8-inch fire wall; a glance at the floor plan will show the general arrangement of the apparatus here installed. The equipment consists of three 500-horse power two-phase generators and two 500-horse-power direct-current machines, each connected to a 500-horse-power Westinghouse compound engine of the type illustrated in Fig. 10. These machines are already in operation, and there is being erected an additional 500-horse-power, direct-current generator, direct-connected to a 500-horse-power steeple-compound Westinghouse engine of a new type. As seen from Fig. 3 the three machines of each class are arranged on either side of the room. Each of the generators rests on a bedplate in common with its engine, to which it is direct

connected by means of a flexible coupling. The space occupied by the steeple engine and its dynamo is only 17 feet by 8 feet 6 inches; the other five double units occupy a space 22 feet by 8 feet 6 inches. There is also installed a revolving transformer, or two-phase motor, used for driving a direct-current arc-lighting machine, and also for supplying the exciting current for the fields of the polyphase generators. An overhead crane affords a quick and convenient method of handling apparatus to be installed or repaired.

Direct-Current Generators.—The generators (Fig. 6) are all of the Westinghouse standard type; that is, they have a slotted, ventilated armature and a cast-iron yoke with inwardly projecting pole-pieces

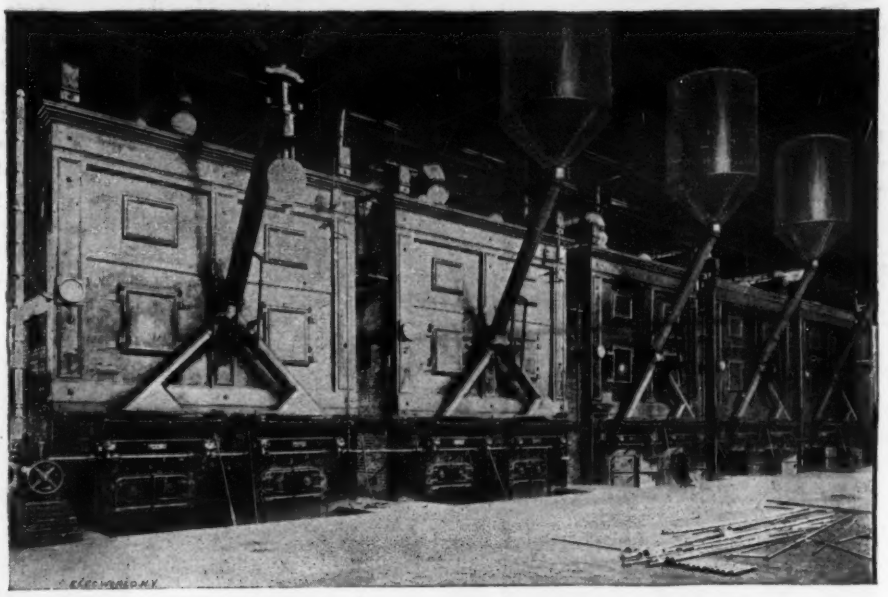


FIG. 7.—BOILER ROOM.

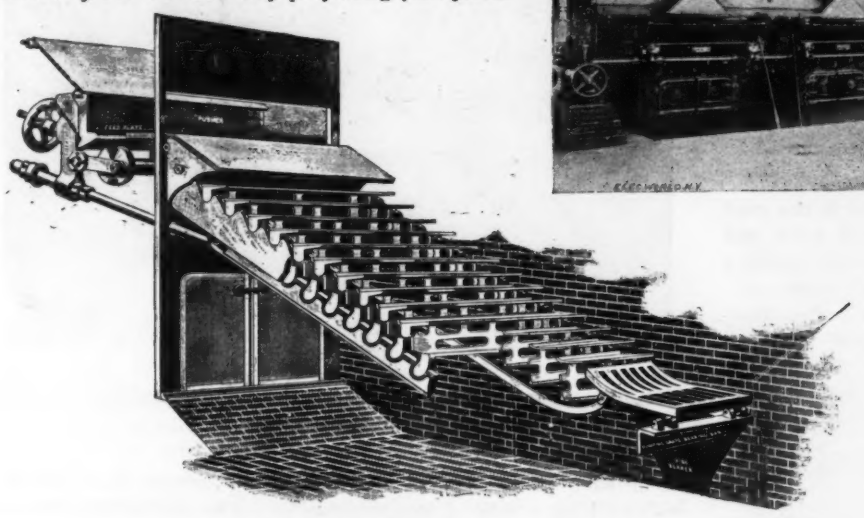


FIG. 8.—RONEY STOKER.

of laminated steel. The general dimensions are 7 feet 10 inches by 8 feet 8 inches and 8 feet 3 inches in height. The armature winding consists of bars of copper threaded through slots in the core and so connected as to give a two circuit winding, which at all times insures equal distribution of current throughout the coils. The armature is 46 inches in diameter, keyed and pressed on to a 7-inch shaft, which is 104⅛ inches in length and 48⅛ inches between journals. The commutator, 26 inches in diameter with a 10½ inch face, is of the best grade copper, properly tempered, and built up with Canadian mica. The current is collected by means of a six-arm brush-holder carrying three carbon brushes per arm. The bearings have a spherical seat, so that they are at all times self-aligning. Below the bearings are large reservoirs for oil, which is carried up to the shaft by means of brass rings, thus affording automatic lubrication. The pole-pieces are built up of sheet steel punchings riveted together; thus constructed they are sent to the foundry and there have the yoke cast solidly about them. This method of construction insures perfect mechanical

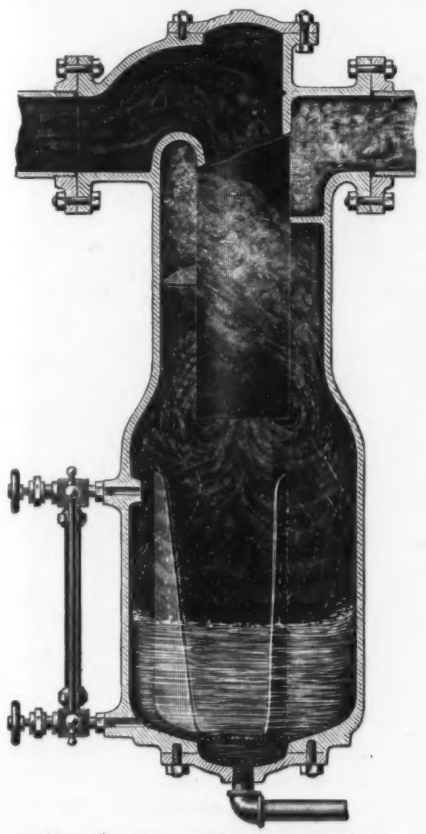


FIG. 9.—STRATTON SEPARATOR.

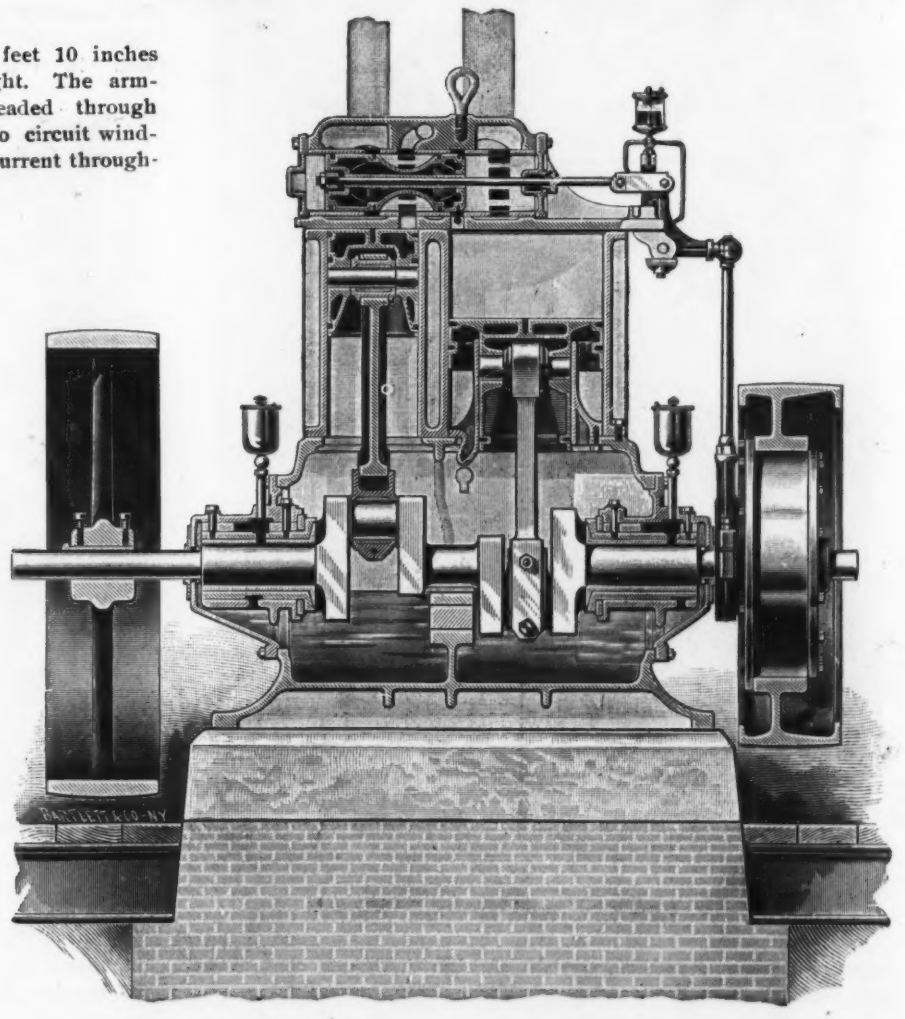


FIG. 10.—500-HP WESTINGHOUSE COMPOUND ENGINE.

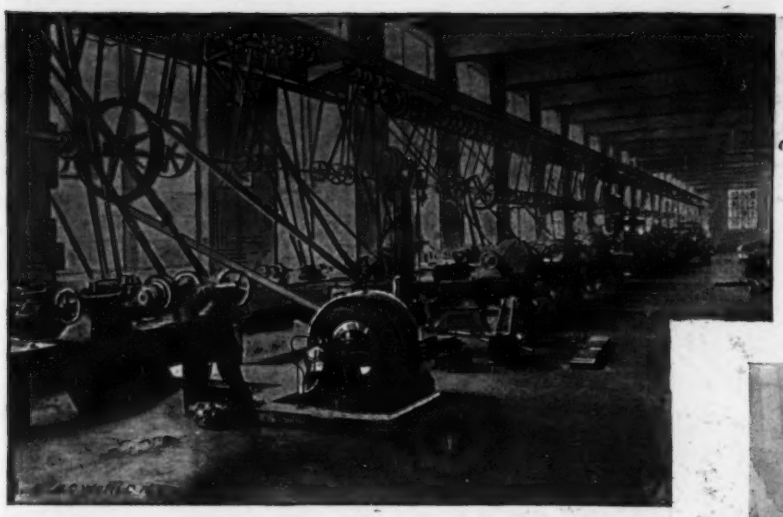


FIG. 11.—TWO-PHASE MOTOR DRIVING LINE OF SHAFTING.

contact between laminated and cast-iron parts, and affords the most efficient form of pole-piece. The lower half of the field yoke and the bearing supports are cast in one solid piece, thereby securing rigidity and strength. The field winding is, of course, compound, the series coils being copper strips of three-quarter inches cross-section. The machines develop 750 amperes at 500 volts when running at normal speed, which is 215 revolutions per minute. The points of commutation are constant under all loads, and the machines will carry, for short periods, as high as 75 per cent. overload without damage or undue sparking. The generators have an efficiency of about 95 per cent.

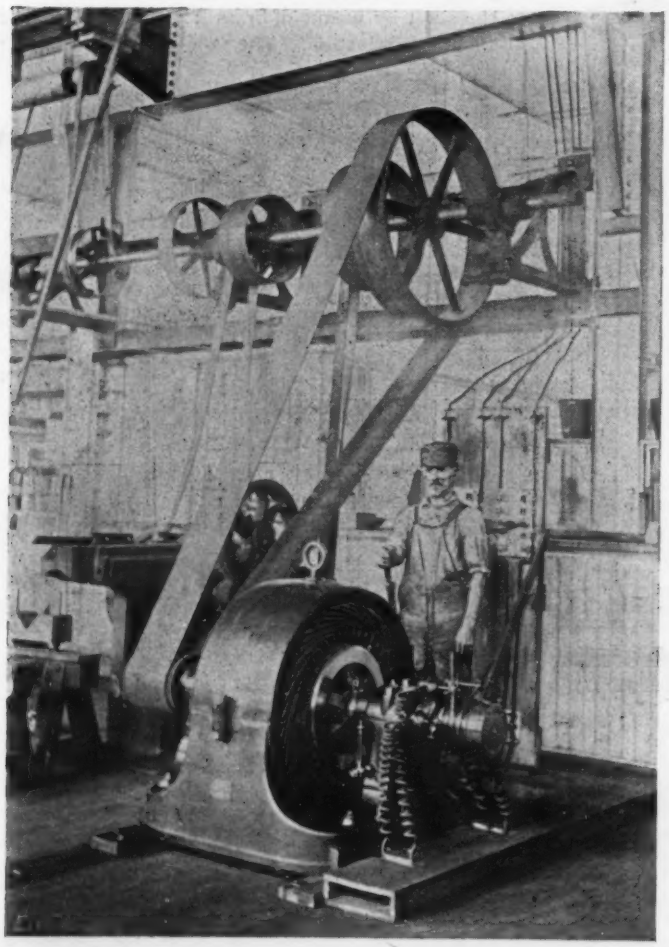


FIG. 14.—60-HP TWO-PHASE MOTOR IN SECTION C.

Polyphase Generators.—These machines, (Fig. 1), are of the same general form and dimensions as the direct-current generators. They have 14 laminated steel pole-pieces, built up and cast into the yoke in the same manner as described above. The exciting coils have but a single winding, as regulation is secured through a rotary transformer which supplies the total field current. The armature is very similar to the direct-current hub or spider, the whole design providing for thorough ventilation during operation. The periphery contains some 92 slots, in which the bar winding used is held in position by strips of rigid insulating material secured by grooves inside of the slots. The type of winding used affords excellent ventilation, avoids the necessity of any binding wires on the surface of the armature, is symmetrical in form, and particularly attractive in appearance. It is of the continuous type, and the four connections are brought out at points 90 degrees from each other, to four collecting rings, where the current is collected by means of copper brushes. The collecting rings are 5½ inches in diameter, with a 1½-inch face. There are four brush-holder arms, two per circuit, which carry two brushes to each arm in order to insure efficient contact. The polyphase machines run at the same speed as the direct generators—215 revolutions per minute. They generate current of 3,000 alternations at a potential of 240 volts. Their normal output is 400 amperes on each of the two circuits, and at this load the machines have an efficiency of about 95 per cent. These generators are usually run in multiple, operating as perfectly and satisfactorily as any direct-current machines.

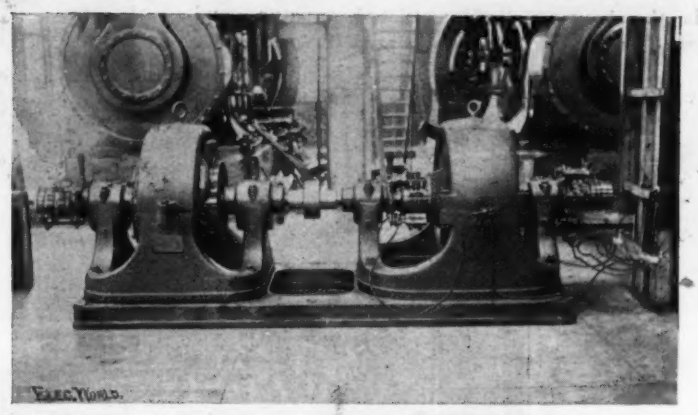


FIG. 12.—ROTARY TRANSFORMER DIRECT-CONNECTED TO D. C. ARC GENERATOR.

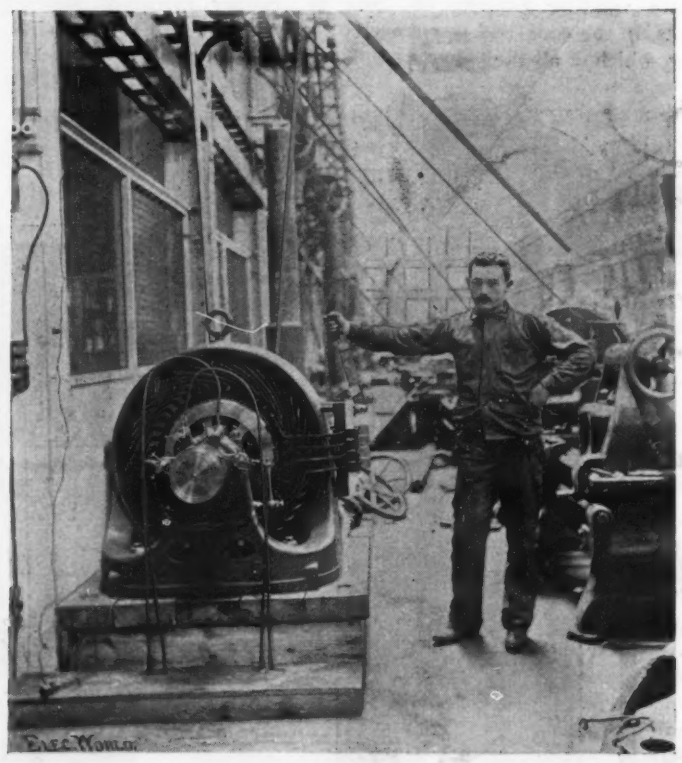


FIG. 13.—40-HP TWO-PHASE MOTOR IN SECTION B.

Switchboards.—At present there are installed two temporary switchboards, which will be replaced by handsome Italian marble incombustible boards, one for the direct current and one for the polyphase system. These boards will be of a new and improved type, a single marble slab over five feet long, two feet wide and one and three-quarter inches thick, taking the place of a number of

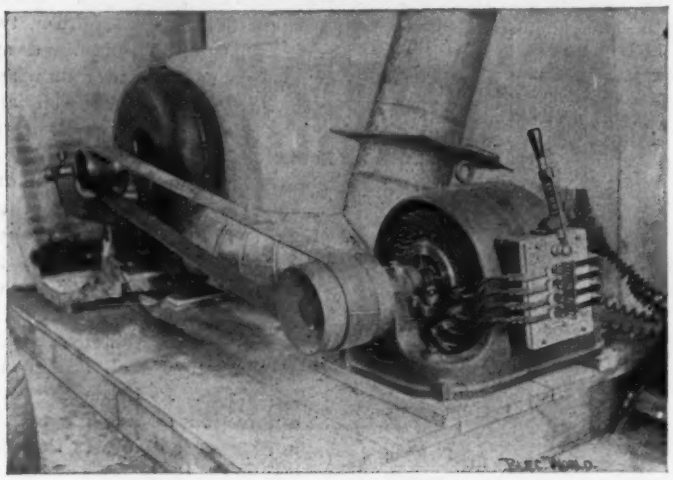


FIG. 15.—5-HP TWO-PHASE MOTOR RUNNING HOT BLAST FAN.

smaller units. The apparatus will be mounted directly on the face of the marbles, which will be supported by iron bracings against the wall. Each board will consist of one load, five generator and five feeder panels. The load panel will be equipped with wattmeters and voltmeters for measuring the total output of the machines in multiple. Each of the dynamo panels will contain signal lamps, main switches, voltmeter and ammeter switches, ammeters, rheostats, and synchronoscopes or phase indicators on the polyphase board for throwing in multiple. The feeder panels will be equipped with lamps, ammeters, fuses or circuit breakers, switches, etc.

Distributing System.—Up to the point at which the current leaves

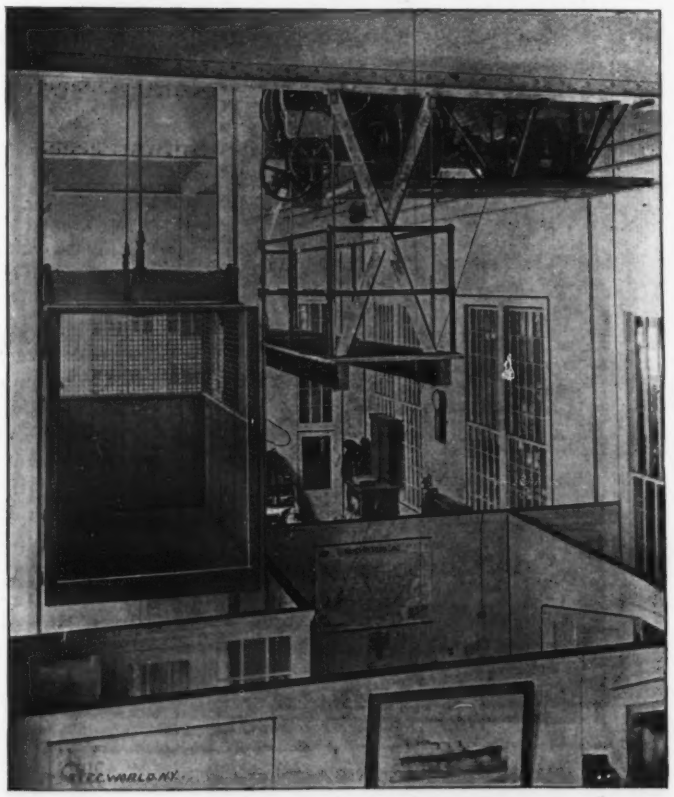


FIG. 17.—TWO-PHASE MOTOR OPERATING ELEVATOR.

the switchboard for supplying the transmission circuits, the installation is identical with that which would be used for long-distance work. If the energy were to be used, for example, at Johnstown, Pa., 75 miles distant, it would only be necessary to connect in converters and transform the potential from 240 to perhaps 10,000 or 15,000 volts, a potential which is perfectly feasible and in use in parts of this country and in Europe.

In the Westinghouse plant the current is distributed through copper cables covered with simple water-proof insulation. These are carried on heavy iron brackets, with special malleable-iron feed-wire insulators manufactured by the Ohio Brass Company. To the main building there are run 18 conductors, arranged as in Fig. 19. The eight cables nearest the support marked 1-3, 1-3, 2-4, 2-4 in the diagram, are each of 500,000 circular mils cross-section and are used for conveying polyphase current used in power work. The wires are arranged as numbered in order to avoid mutual and self-inductive affects, wires 1 and 2 conveying one of the two currents,

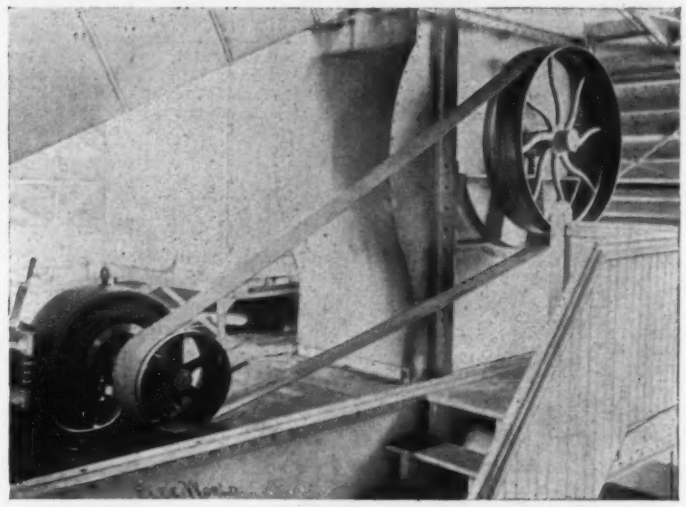


FIG. 16.—40-HP TWO-PHASE MOTOR DRIVING VENTILATING FAN.

and 3 and 4 the other one, which differs 90 degrees in phase from the first. The four outside wires marked "+ and +, and —," are also of 500,000 circular mils cross-section and are used for direct currents, supplying the testing departments. Of the lower

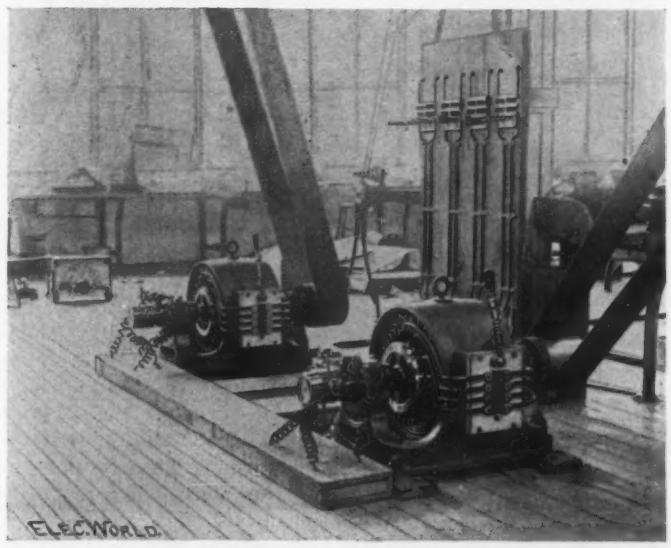


FIG. 18.—TWO 30-HP TWO-PHASE MOTORS DRIVING LINES OF SHAFTING IN SECTION D.

six cables the four inside ones are marked 1-3, 2-4, and convey polyphase currents used for lighting. These cables are of 500,000 circular mils cross-section. The two outside cables marked "plus" and "minus" are of 250,000 circular mils cross-section and convey direct current used for the operation of some small stationary motors and for various other purposes. Energy is conveyed to the carpenter shop by four 250,000 circular mils cables, transmitting polyphase currents. The punch shop is supplied with similar energy through eight 210,000 circular mils cables and the warehouse by four 500,000 circular mils cables. At the various motors four connections are made to the mains, through two double joint switches and fuses, as shown in Fig. 15.

As a rule the Tesla motors are belted, as shown in Figs. 11, 12, 13 and 18, to short lengths of shafting from which the machinery is driven. A detailed description of the latest forms of the Westinghouse polyphase motors will be given in the next issue. The location of the motors and their horse power is given in the appended table:

220-VOLT, POLYPHASE MOTORS.

	Horse Power.									Total
	10.	15.	20.	25.	30.	40.	60.	75.	Motors.	H. P.
Machine Shop	2	1	4	1	9	8	1	..	26	790
Detail Department	2	..	4	..	..	..	..	..	6	100
Blacksmith Shop	1	2	3	.	..	1	..	..	7	140
Punch Shop	2	..	2	..	1	..	..	..	5	90
Brass Foundry	2	..	1	..	..	..	..	..	3	40
Carpenter Shop	1	..	2	..	1	..	..	1	4	155
Paint Shop	2	1	2	..	..	..	..	..	6	85
Tota's	12	4	18	1	11	9	1	1	57	1400

500-VOLT DIRECT CURRENT MULTIPOLAR MOTORS.

	Horse Power.			
	3½	5	7½	10
Two 30-ton Shaw Cranes, 67 ft. span	2	..	2	2
Two 10-ton Sellers Cranes, 32 ft. span	2	2	2	..
Two 10 ton " " " "	..	6	..	..
Two 10-ton Gale & Towne Cranes, 22 ft. span	2	2	2	..
Totals	6	10	6	2

Throughout the factory there are 17 electric, freight and passenger elevators which were at first operated by direct current;

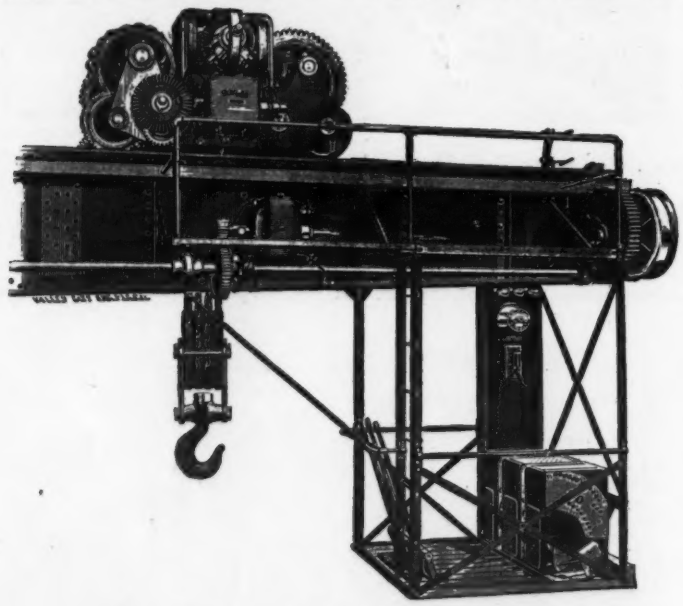


FIG. 20.—BRIDGE END OF 30-TON CRANE.

these are rapidly being replaced by multiphase motors. The elevators are all belt driven as shown in Fig. 17, but there is no objection to their being direct connected whenever so desired. The motors vary from 20 to 30 horse power capacity. Fig. 20 gives a view of the bridge end of one of the two 30-ton Shaw standard single trolley electric cranes in the main shop, which were supplied by Manning, Maxwell & Moore, of New York. These cranes are equipped with the electric and mechanical brakes and operated by Westinghouse motors especially designed and built for them. The span is 67 feet and each of the cranes has a travel the full length of the shop.

Electric Omnibuses.

It is reported that two lines of omnibuses, to be electrically propelled, will shortly start running between Hammersmith and Liverpool Street stations, London—one line running north of the park by Notting Hill, Bayswater and Oxford Street; the other on the south by Kensington and Piccadilly.

Needed More Light.

The Electric Lighting Committee of Belfast, Ireland, at its last meeting considered an application from the gas company for the supply of electric current to the gas works. Some amusement was caused by the application, which was referred to the city engineer for report.

Telephone Trunk Lines in England.

The first and most important stage in the establishment of a telephone system for the United Kingdom in conjunction with the post office was, we learn from the London *Electrical Engineer*, recently completed, and London for the first time put into telephonic communication with Edinburgh, Glasgow, Belfast and Dublin. The most easterly wire from London runs to Ipswich, by way of Chelmsford and Colchester, and the most southernly to Brighton, two wires being used in each case. The Midlands are served by a line of from sixteen to four wires, passing through Nottingham, Sheffield and Leeds, to Newcastle, and feeding Derby, Birmingham and Leicester from Sheffield and Nottingham; Manchester and Liverpool, on the one side, and Hull on the other, from Leeds; and Hexham and Morpeth from Newcastle. At Birmingham the line is taken southwest to Newport, Cardiff and Swansea, and, by another network, to Bristol, Exeter and Plymouth. At Leeds, the communication strikes off to the northwest, and passes through Carlisle to Glasgow and Edinburgh, for Scotland, and to Portpatrick, where a submarine cable across St. Patrick's Channel is laid to Donaghadee, and touch is gained with Belfast and Dublin. These lines are already completed and in working order; but there is still in progress a syste · direct from London to Birmingham, leading on to Derby, where it will branch to Liverpool and Manchester, passing through Cottonopolis to a point where it will join the Leeds-Carlisle communication. The direct service from London to Bristol, Southampton and Portsmouth will be secured by six wires running to Salisbury, where they will separate, four turning to the Bristol Channel and two to the Solent. A couple of wires from Newcastle to Sunderland, and two more from the same centre to Darlington and Stockton, will complete the scheme of the department. Altogether, a total of 10,375 miles will be covered, and 2,829 tons of copper will be consumed, in the following proportions: 2,719 miles, at 800 pounds of copper per mile per wire; 4,914, at 600 pounds; 2,646, at 400 pounds; and the submarine cable, 24 miles in length which, being quadruple, gives a total of 96 miles. The mileage at present completed is 7,595 miles. The extent of private undertakings to be presently absorbed is about 28,000 miles. The distance to Dublin, as traversed by the wire, is 467 miles, which is a notable increase on the 334 miles followed by the railway from Euston *via* Holyhead. The longest circuit over which the postoffice authorities have spoken by linking the largest possible number of wires is 1,270 miles, and the result of the experiment is considered by them to be quite satisfactory.

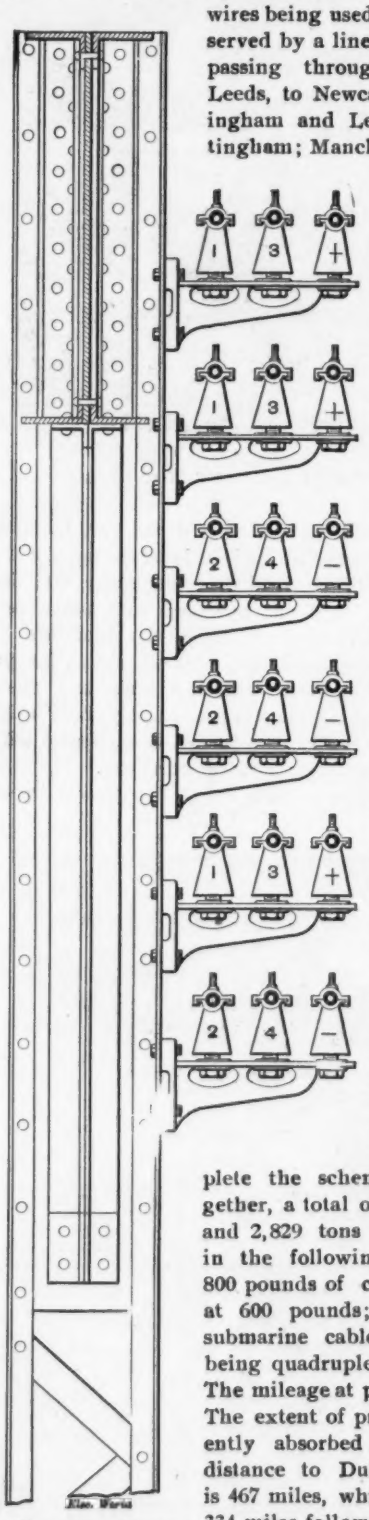


FIG. 19.—POLE LINE CONSTRUCTION.

Amount of Light Per Capita in Paris.

The amount of artificial lighting in Paris in 1855 is said to have been 3,765 candle-hours per year per capita, which was increased to 11,302 in the year 1889.

Polyphase Currents and Motors.

Much confusion has been created in the minds of beginners by the habit of some writers of using current in the singular when writing of polyphase currents. This, of course, is a manifest error, the presence of the word *phase* in itself carrying a contradiction. As will be illustrated later on, a polyphase system is one in which two or more simple alternating currents are employed, but which do not simultaneously pass through an identical value, as, for example, the maximum value. That is, one of the two simple alternating currents of a two-phase system passes through its maximum value a quarter period after the other, while in the three-phase system the three simple alternating currents have phase differences of a third of a period.

In every alternating-current circuit the potential is first positive

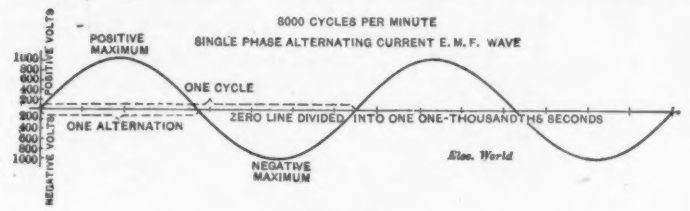


FIG. 1.

and then negative; that is, the current in one half-period flows in one direction and in the other half-period in the opposite direction. This change of value of the potential, or electromotive force, of the simple alternating current is usually graphically represented by some such wave line as shown in Fig. 1. At any instant the value of the E. M. F. is determined by selecting a point on its wave corresponding to the proper time, as indicated on the zero line, and referring the point to the scale at the left. The part of the curve above the zero line is usually taken to indicate positive potential, and that below the zero line as negative potential. It should here be remarked, however, that the zero line shown in the diagrams is one chosen for convenience, as the true zero line would be one tangent to the lower portion of the curve. Reference to the diagram will show that an alternation occupies half the time of a cycle, and that a cycle or period is the total change that takes place in the E. M. F., from zero to maximum in one direction, back to zero and to maximum in the opposite direction and to zero again. With a bipolar machine one cycle is completed with each revolution of the armature, and with a four-pole machine, two cycles per revolution, etc. The fluctuations in E. M. F. go on continually and very rapidly in every alternating-current circuit and distinguish it from a direct-current circuit, in which the voltage is constant and the flow of current continuously in one direction. In simple alternating-current circuits it has been customary to use about 16,000 alternations or 8,000 periods per minute, in which case, a complete period occupies only about 1/133 part of a second; lately, however, practice has tended to reduce the frequency as low as 3,500, and in some cases even to 1,500 per minute.

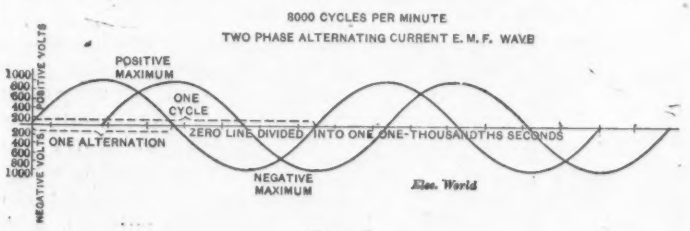


FIG. 2.

Polyphase currents consist of two or more simple alternating currents definitely and accurately related to one another as to time. Fig. 2 represents the E. M. F. waves of two-phase currents. It will be noticed that the waves are one fourth of a cycle, *i. e.*, 90 degrees apart, the maximum of one wave occurring during the zero value of the other wave, and vice versa. In the two-phase circuit the E. M. F. waves always maintain this relation to one another. If the E. M. Fs. are applied to separate circuits and kept entirely independent, they would produce two simple alternating currents, one always a little behind the other. We may suppose these currents to be produced by two alternators having the same number of pole-pieces, the same number of teeth on their armatures, and with their shafts rigidly connected together, so that when the armature teeth of one machine are opposite its pole centres, the teeth of the other armature are midway between the poles of its field. If the currents of these machines were kept separated, two wires being used for each phase, we would have the four-wire two-phase system.

Fig. 3 represents the three-phase system. It will be noticed that there are three waves regularly placed with respect to one another, one third of a cycle apart; that is, three-phase currents may be considered as being generated by three machines whose shafts are so connected that their armature teeth are respectively behind one another by two thirds the distance between their pole centres. If the leads from these machines were kept separated we would have a six-wire system, but each pair of wires can be so connected with each of the other two pairs, that three wires serve for three currents, which, as stated before, have phase differences of one third of a cycle. In practice it is not necessary to use separate generators to secure polyphase currents, as it will be readily seen that the teeth and coils of a single armature could be so arranged with respect to its pole-pieces as to give the required effects.

To look at the matter from a little different standpoint, we may consider the similarity between a direct current and a polyphase generator. As is well known, whether a machine shall give a direct or alternating current depends, not on the number of pole-pieces nor the form of armature winding employed, but solely on whether the armature windings are connected to a commutator or to collecting rings. Every dynamo armature has generated in its windings an alternating current, which may be rectified by means of a commutator, or used as an alternating current through the interposition of collecting rings. This is exemplified in rotary transformers, which have collecting rings on one end of the armature and a commutator on the other. When driven as a generator, these machines will supply either direct or alternating currents, as preferred, or direct currents may be sent in at the commutator end and alternating current taken off the rings, or vice versa. Such machines are in actual operation, supplying both direct and alternating currents, at Rochester, N. Y.

FIG. 3.

Suppose we take a simple two-pole direct-current dynamo and put a pair of ordinary collecting rings on its armature, in addition to the commutator. If these rings be connected to opposite commutator bars, then the current derived from them will be an alternating current. Two more rings may be added to the armature and connected to two other commutator bars at 90 degrees from the first. These last two rings will also give an alternating current similar to that of the first two, except that its maximum value will occur at the time of zero value of the current from the first pair of rings. Thus it will be seen that we attain two-phase currents, and all the while the *armature* currents are exactly the same as those in the machine when used for direct current.

The general impression prevails that there is something particularly mysterious and intricate about the action of a polyphase motor, and that it is entirely different in action from the ordinary direct-current motor. But it will be recognized that the machine just described can, of course, be reversed and run as a motor, the currents in the armature, and the reaction between the armature and field being the same, whether the armature is supplied by direct current or by polyphase alternating currents. This motor, when supplied with alternating current, is a synchronous type of motor, in which it is essential that the speed of rotation of the armature should correspond to the rate of alternation of the current; this follows from the fact that the currents in the armature must correspond with those which would flow in the direct-current machine, in order that the poles produced by the armature currents may be maintained in fixed position with relation to the field poles. If the armature speed is a little less than synchronous speed, it is clear that the poles produced by the armature will not maintain a constant position, but will rotate at a speed depending upon the relation between the speed of the armature and the rate of alternations. The reaction of a revolving pole of this sort upon a fixed and constant field will tend to produce rotation, sometimes in one direction and sometimes in the other direction, the result being that the

armature will come to rest, or cannot be started in motion. If, however, the field pole itself were to revolve and keep just ahead of the pole produced in the armature, then there would be constant reaction and pull, or torque, in one direction. This is accomplished by a different type of field, in which the currents are induced by the armature itself, very similar to the currents in the secondary of an ordinary converter. The armature induces the currents in the field, which in turn produce poles which are displaced in position from those in the armature, and reaction between the poles takes place, producing motion similar to that in the direct-current motor.

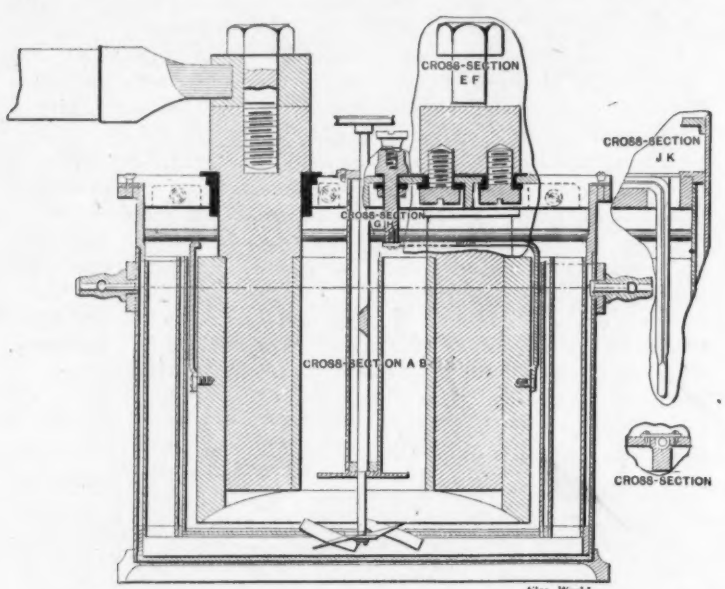
The two-phase synchronous alternating-current motor is therefore essentially the same as an ordinary direct-current motor, except that the alternating currents which are required in the armature are supplied directly instead of being produced from a direct current by a commutator. In the non-synchronous type of motor the field poles are not produced by a separate direct current but by an induced current, and these field poles are not fixed in position, but are transferred from point to point in the field, and maintain such a position as to give the proper reaction and torque between the armature and the field.

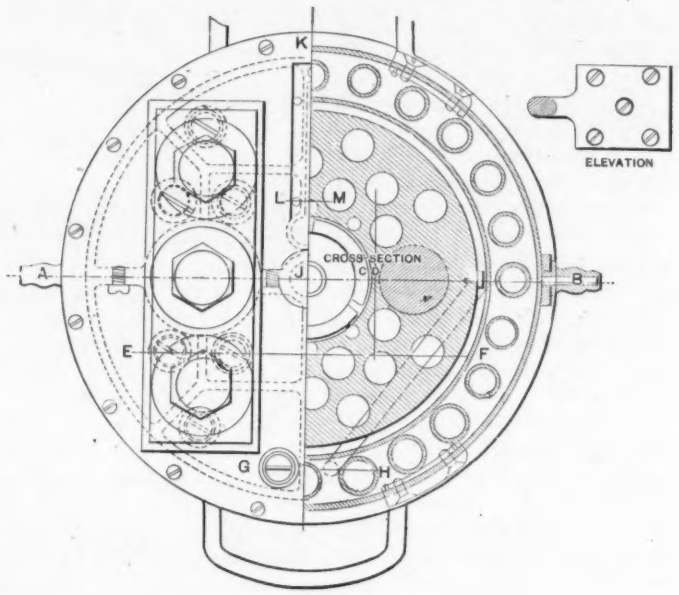
A further modification of the alternating-current motor, which seems a very radical one in form, but is really a very slight one in theory, is that in which currents are supplied to the outer or fixed element instead of the rotating element. The outer part is here really the armature. For simplicity and to avoid confusion the words "armature" and "field" have been discarded at the Westinghouse works, and "primary" is applied to the element to which currents are supplied, either "stationary" or "revolving" as the case may be, and "secondary" is applied to the element in which currents are induced, and this may also be either "revolving" or "stationary," depending upon the type of construction.

This relation between the two kinds of apparatus is very clearly exemplified in the types now being produced by the Westinghouse Company. It is very interesting also to see how the types of alternating and direct-current generators are similar in general form, and in many cases the construction is almost identical, with the exception of the substitution of collecting rings for commutator.

Standard Resistances for Strong Currents.

The new standard resistances of the Berlin Reichanstaldt for measuring large currents by the voltage at the terminals of a known resistance, are described by Dr. Feussner in the *Elektrotechnische Zeitschrift*, from which we reproduce the accompanying illustration. The first resistance has a value of 100 microhms, and can be used for currents up to several hundred amperes, and for a short time up to 1,000; the second resistance has a value of 10 microhms and is intended for currents up to 10,000 amperes. Instead of the usual bands of metal, these resistances are made of a casting of manganine in the form of a short hollow cylinder, having about the same width as its diameter, and having a thick wall, which appears from the illustration to be about equal to a little less than one third of its outside diameter; numerous holes are drilled through it, parallel to the axis, so as to increase the resistance to the desired amount, and to serve for the circulation of the oil in the bath in which the cylinders are placed. The connectors are made of large copper bars inserted in two holes, parallel to the axis and diametrically opposite to each other, the current therefore flowing through the two halves of the manganine ring in multiple; these terminals are carefully soldered with silver. The connections for the voltmeter are made of manganine strips screwed to the cylinder near where the copper leads enter it, and are soldered with tin. Great care is taken to have the leads sufficiently large; those in the small apparatus are made of round copper bars 15 mm (about ⅝ in.) in diameter, and in the large one about 50 mm (about 2 in.) in diameter, being a little less where they pass through the casting. It is not stated why the leads are not formed of manganine in the form of large blocks cast as a part of the original casting, to which the copper is then fastened; this would avoid all thermo-electric effects in that portion of the resistance which is used in the measurement.





STANDARD RESISTANCES.

Leakage Currents and Metallic Sodium.

Our readers are aware through our columns of the recent discussion in England as to the formation of metallic sodium by leakage electric currents, and from what follows it will be seen that in Boston a similar case has been observed. At the request of the Boston Fire Underwriters' Union, Messrs. Forbes and Glidden of that city recently made an examination of a substance found in the casing about the electric mains in the basement of the Pray building, and we give below an abstract of their report.

The substance discovered was in reality impure metallic sodium mixed with partially disintegrated wood, the metallic sodium being the product of an electrolytic decomposition of impure sodium hydrate. This sodium hydrate came from the cement mortar used in laying the brick wall of the basement, upon which the wires were supported. Some of the hydrate may have possibly worked its way through the wall from the cement used in the foundation of the paved street (Washington Street), immediately adjacent.

The electric current which caused the electrolytic action was due to a leak inside the casing from one of the mains to another, the leak having been produced by the action of the sodium hydrate on the insulating covering of the wires. This covering was what is known as "Weather-proof," consisting of a cotton braiding covered with tar, which material is readily attacked by sodium hydrate and its insulating properties destroyed. The general arrangement of the wires in the front of the Pray Building is shown in the accompanying sketch.

The three street mains enter at the point *A*, and pass through the safety catches *C*, and meters *M*, to the wooden casing which starts at *D*. From this point the wires are run on porcelain knobs inside the wooden casing, behind the water pipe *P*, turning upward at *E*, and leaving the wall at *G*. Inside the casing the wires were partially covered by an insulating tubing consisting of tarred paper.

The deposit of sodium was found at the point marked *S* on the sketch and extended over an area represented approximately by the shaded portion. The wood at this point was badly eaten and discolored by the caustic action of the sodium, and for some distance around, especially along the top of the casing, was soft and wet.

For several months before the sodium was found, a slight smoke had been noticed to issue occasionally from the casing. When the front of the casing was removed, the wires, tubing and woodwork about the point *S* were covered with a thick liquid, which had dried in places to a white substance resembling discolored salt and which was slippery to the touch and strongly corrosive. The metallic sodium was smoking and when moistened and struck with any hard material gave off flashes of fire.

The following tests were made shortly after the discovery of the deposit, upon which the explanation given above is based. The substance was determined to be mainly metallic sodium by its

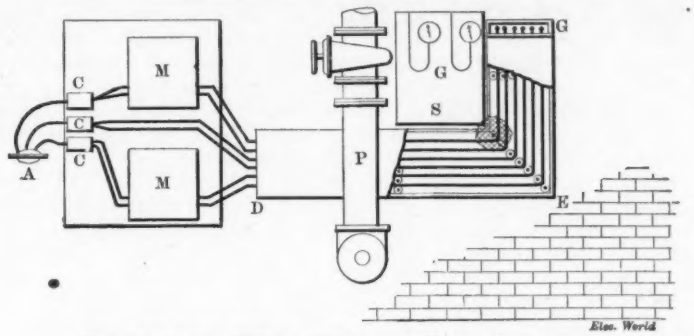


DIAGRAM OF WIRES ENTERING PRAY BUILDING.

appearance and characteristic reactions, and by its color in the Bunsen flame. The sample upon which the test was made was about half wood partially disintegrated, adhering to which was a mass composed of white sodium hydrate on the outside, with the metallic sodium in the centre.

Samples were taken from the surface of the wall at numerous points along the front of the basement, each of which gave a strong alkaline reaction. The moisture on the wall was also strongly alkaline.

The insulation on the wires about the point *S* was found to be practically destroyed. The upper two wires (negative) were in the worst condition; the middle two (neutral) were nearly as bad; while the lower two (positive) had not been so much affected.

The outer covering of tar, especially on the negative and neutral wires, had been dissolved by the action of the caustic, leaving the braiding bare and saturated with the sodium hydrate, which had dried white in places.

Opinions Regarding the Berliner Opinion.

The following views of managers of opposition or independent telephone companies as to the probable effect of the recent decision in the Berliner case will show how the subject is viewed by these gentlemen:

"The article and the editorial in THE ELECTRICAL WORLD explaining the opinion of the United States Circuit Court of Appeals in the Berliner case is evidence to us that you have the interest of your telephone subscribers to heart, and that you will continue to look out for them in the future as you have in the past.

"FLORIDA TELEPHONE & CONSTRUCTION COMPANY,
"James D. Randall, President, Memphis, Tenn."

"The question is entirely a simple one so far as concerns the Standard Telephone Company. We are in the telephone business, and have all the orders in hand and as many in sight as we can possibly handle, so that our hands are full taking care of practical business. "STANDARD TELEPHONE COMPANY,
"Thurlow Weed Barnes, President, New York."

"I write to thank you sincerely for what you have published in THE ELECTRICAL WORLD relating to the opinion in the Berliner telephone patent case. Until I had read this I was at a loss to obtain intelligent information bearing upon the subject. We propose to go right on with the business and are meeting with wonderful success. Our plant has been removed to Madison, Wis., where we are meeting with success beyond our expectation.

"S. S. KILVINGTON, M.D., Minneapolis, Minn."

"It seems to be the current impression that while the Bell Company is looked upon as usurping the rights it is enjoying by appropriating privileges that in reality belong to the public, the public at large, particularly those who have capital to invest in this line of industry, are afraid of the power wielded behind the throne by the Bell Company. After having fully gone over the history concerning the telephone situation it would appear to the average person that it is impossible to get and sustain a decision in even the higher courts adversely to the interests of this company.

"THE NOWOTNY ELECTRIC COMPANY,
"John S. Nowotny, General Manager, Cincinnati, O."

"THE ELECTRICAL WORLD'S digest of the opinion in the Berliner case, giving some interesting data, reached here ahead of any other information on the subject, and for this we feel you should be particularly complimented. The WORLD is the only electrical paper, as far as I know, that has put before its readers and the general public a digest of the situation up to the present time. In other words, you seem to have got about three or four days ahead of the others. There is to be an exhibition here in the Bullitt Building, commencing Thursday, June 27, of our telephone and the Gould-Smith switchboard. A complete working switchboard showing entire system will be in operation. We have, we believe, the only non-infringing system, and certainly we have got something that will be new to the public as well as the readers of the electrical papers.

"UNITED STATES TELEPHONE CONSTRUCTION CO.,
"A. H. Chadbourne, Gen. Mgr., Philadelphia."

"The decision in the Berliner case will probably have the present effect of keeping some uninformed persons, and others naturally timid, from aiding in the development of the independent telephone field, thus working an injury to themselves, the trade and to the public, and the carrying out to such extent of the probable designs of the Bell Company. But that the Bell will be able ultimately to maintain a monopoly of the telephone business through that monumental piece of patent jugglery—the so-called 'Berliner patent of '91'— we cannot believe. 'Our friends the enemy' claim that this patent covers all forms of microphone transmission. They are working a stiff bluff—if we may be pardoned the expression—perhaps thinking there is nothing to lose by claiming too much. They appear to base this claim on the 'constant-contact, variable-pressure' combination. The Berliner, Edison, Bell and Hunnings patents of '77 either did or did not involve this principle. If they did not then, they do not now. If they did then involve this principle, why should a so-called patent issued some 14 years later prevent the public from enjoying the benefits to be derived from these expired patents?

"THE RAWSON ELECTRIC CO.,
"T. M. Brush, Secretary and Treasurer, Elyria, O."

Output of Polyphase Machinery.

To the Editor of The Electrical World:

SIR:—In your editorial of June 15, commenting upon my paper, dealing with the output of polyphase machinery, you make a statement which might lead to the impression that the heating effect in an armature, and the consequent limitation in its output, had not been taken into account in the treatment of the subject. By referring to the paper in question it will be seen that the basis of comparison of output under the several conditions considered is that of identical copper and iron losses, which is equivalent to a comparison on the basis of equal rise in temperature. The armature iron loss of the polyphase generator is the same as that of the direct-current generator, and the armature iron loss of the rotary transformer is assumed the same as that of the direct-current generator, although in reality it is less, and for this reason the result obtained for the output of the rotary transformer is slightly low. This difference in iron loss was touched upon at the close of the paper, but was not brought into the discussion because it was thought that the complication thus introduced would not compensate for the slight difference in the result. In reality the iron and friction losses might be neglected in the case of the rotary transformer on the assumption that the power required for them is supplied to the *pulley* of the machine. For the copper loss due to that part of the armature current which supplies power for the iron and friction losses is small, and is partially, in some cases wholly, offset by the decreased iron loss referred to above. For this reason equation (8) of the paper is sufficiently accurate for all practical purposes although curve *B* was plotted from equation (7). If, as it seems, the paper was not sufficiently explicit upon these points, I take this opportunity of remedying the oversight.

Pittsburg, Pa. RALPH D. MERSHON.

DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

BY CARL HERING

COMPILED FROM THE PRINCIPAL FOREIGN AND AMERICAN JOURNALS

Note.—The object of this department is to give a digest of the principal technical articles on electrical subjects appearing in American and foreign periodicals. The abstracts will contain, briefly, the nature of the article, its object, and the most important data or conclusions, as far as the limited space will admit. Abstracts made by the authors, editors, or publishers are solicited and should be sent to the Philadelphia office of THE ELECTRICAL WORLD, 927 Chestnut Street. They should be forwarded so as to be received at least as early as the journal in which the original articles appear; they should not be longer than the importance of the subject warrants, and must comply with the general outline given above, the compiler reserving the right to edit or reject them. Such abstracts may be sent in the English, French, or German languages. It will be to the advantage of all concerned if editors of non-electrical journals or of such electrical journals as are not regularly abstracted, will send the compiler a copy, specially marked, in which any important electrical article appears.

DYNAMOS, MOTORS AND TRANSFORMERS.

Theory of the Dynamo.—"L'Eclairage Elec.," June 1, contains a long article by Mr. Hanappe on "A Theoretical and Experimental Study of a Bipolar Dynamo for Di-phase Currents." His object is to apply known principles of the theory of the dynamo to finding a method of calculation sufficiently accurate, for practical purposes, for determining without experiments the external characteristics of a generator, the angles of lead for different outputs and the variation of the loss of flux; he deals largely with the calculations concerning the flux; his formulæ do not appear to be too complicated for practical application. He shows that the old method of calculating dynamos does not give results which agree with those obtained in practice, except for the voltage on open circuit, whereas his method gives approximate values which accord with those found in practice.

Alternators.—A brief abstract of a recent Royal Society paper by Dr. Hopkinson and Mr. Wilson is published in the Lond. "Elec.," June 7; it is reprinted in THE ELECTRICAL WORLD, June 22, p. 711.

Single-Phase Alternating-Current Motors.—An Institution paper by Mr. Eborall is reprinted in the Lond. "Elec. Rev." beginning with the issue of June 7; he reviews what has been done and attained in this field; it is an interesting summary but does not appear to contain much that has not already been published.

Connecting Alternators in Parallel.—A system is illustrated and described by Mr. Vietze in the "Zeit. fuer Elek.," June 1, for three-phase machines, by means of which the voltage and phase difference of the machines to be coupled are measured with a simple apparatus.

Dynamo Without Iron.—An illustrated description of the machine of Prof. Pietzker taken from the German (referred to several times in these columns), is published in "L'Elec.," June 8; this machine is of no practical interest.

LIGHTS AND LIGHTING.

Train Lighting.—In Mr Weeks' serial in the Lond. "Elec. Eng.," June 7, he describes the present plant used on the Great Northern Railway, accompanied by numerous good illustrations. All the machinery is placed in the baggage car, the dynamo being driven from the axle of the car by means of a countershaft; there are 22 cells of accumulators in each car, and there are 11 cars to a train, each train being provided with 552 cp of light; eight trains are now running regularly and the maintenance per year per train is about $750; the initial cost of the outfit is about $182 per car, the average candle-power is 50 and the cost of supplying the light is 0.052 cent per candle-power-hour; the lighting is said to be successful.

An article of a general character giving but little detailed information is published in "L'Elec.," June 8.

Differential Chain Lamp for Continuous or Alternating Currents.—An illustrated description of the Kremenezky-Mayer lamp is published in the "Zeit. f. Elek.," June 1.

Thermo-Regulated Apparatus in Practice.—Mr. Bartholomew, in the "Elec. Eng.," June 19, gives his experience in trying to make a commercial arc lamp, operated by a thermo device in place of the magnet; after spending three years of time and $20,000 he has come to the conclusion that the thermo-regulated apparatus is commercially impracticable; heat, cold, dust, steam, smoke, miscellaneous fumes, etc., interfere with its operation; he believes that a thermal device cannot replace a magnetic one when responsiveness is requisite.

POWER AND HEAT.

Hydro-Thermoelectric System.—The article by Mr. Gooch (see Digest, June 1,) is concluded in "L'Eclairage Elec.," May 25; he points out the advantages of this system for various purposes; most of these have already been stated in these columns. An installation of 45 kw will be sufficient for welding pieces 25 cm (he probably means mm) in diameter in 40 seconds; in spite of the cost of the energy the cost of welds made by this method contrasts favorably with that of the usual method; he points out the advantages of being able to localize the heat by insulating those parts which are not to be heated; this feature may also be used to advantage in forging, tempering or hardening, in the latter especially when only a portion is to be hardened; he describes its application to wire drawing, drop forging, tempering, cleaning of castings, brazing and electrochemical operations; for tempering, a solution of carbonate of potash in glycerine is used in preference, as the heating is more rapid, more delicate and more easy to control; for the subsequent chilling the same bath is used the current being merely broken; for superficial hardening he suggests the application to the bearings of car axles which are hardened to a depth of about 0.5 mm, also to the edges of axles, hatchets and similar instruments; the electrolyte for this is a solution of carbonate of potash in water, and the voltage should be relatively high for making the operation more rapid. Pieces of conducting metals may also be heated without contact with either of the electrodes, by merely suspending them in the liquid and bringing them near to the negative pole; this is used for small metallic objects. The application of the method in the process of tinning sheet iron has not yet been fully developed; the process is used largely for brazing, especially in the manufacture of bicycles, on account of rapidity; for this the glycerine bath is used and the positive electrode should be changed according to the soldering metal which is used; in this last application the reducing action of the hydrogen forms an important part; in the treatment of minerals the most refractory can be easily melted; all metal can be worked by this process.

Electric Crane at the Port of Havre.—The "Mem. Soc. Ing. Civ." for April contains a very long paper by Mr. Delachanal accompanied by a number of good illustrations; he gives an account, at considerable length, of the comparative tests made with different electric systems each of which is described, the results of the tests being given in detail. Among the conclusions which he arrives at from these tests are the following: when the motors are connected in series (he apparently means series-wound motors) and are provided with a rheostat they are well adapted to the work and have a smooth motion enabling them to be substituted with advantage for local steam engines; motors in multiple (he apparently means shunt-wound motors) are neither as easily applied nor is their action sufficiently smooth to replace steam engines; the large current impulse at starting and the sparking when stopped requires that they be kept revolving continuously; the compound-wound machines approach both of the others without having the advantages of either and they are therefore not to be recommended; the expenditure of energy for producing the same tractive effect is about 40 per cent. greater in series than in the shunt motors. The general results of the investigations are that the cranes themselves are not modified appreciably by the substitution of electric power, but the cost of operation is less if the number of cranes is sufficiently great; the dangers accompanying isolated boilers then no longer exist, those due to freezing are avoided, the whole apparatus is more easily moved and no time is lost in starting the individual fires.

Tri-Phase Transmission Plant.—A brief description of a plant of the Fives-Lille Company is briefly described in "L'Elec.," June 8; the current is transformed up at the sending station by means of transformers; there are a few small motors on the lighting circuits; very little information is given.

Water Power Plant in Japan.—According to "Elec. Friend" (Japan) for April a plant is projected for supplying the city of Osaka with 30,000 hp generated by water power.

Transmission of Power.—Several papers on electrical transmission of power read at the convention of the New England Cotton Manufacturers' Association, are abstracted in the "West. Elec.," June 15. In one by Mr. Rice on "Water Power Development and Its Cost," he gives some data regarding several electrical installations; in a projected plant at Thornton Shoals, Ga., it is expected to develop 14,000 hp and transmit it to Atlanta, a distance of 7.5 miles; the power plant will contain 13 units of 1,000 hp each and two of 500; the entire cost is estimated at $46 per horse-power delivered at the switchboards in the power house; the operating expenses per year are estimated at $4.20 per horse-power. In

another proposed plant of 36,000 hp the assumed cost will be $73.97 per horse-power and the estimated cost of operation will be $6.09. In another 20,000-hp plant the estimated cost is $46 62 per horse-power, the cost of operation being $4.09 per horse power. In a paper by Messrs. Stone and Webster on "Electric Driving of Textile Establishments" they discuss the subject but give nothing new. In a paper by Mr. Eccles on "Operating by Electricity from a Distance," he gives some details of the operation of the three-phase plant at Taftville. A paper by Mr. Paine on "Electrical Driving of Textile Establishments," a long abstract of which is given, treats the subject in a general way and is intended apparently for non-electrical engineers.

Electric Mine Hauling Plant.—A description by Mr. Sprague of the plant at the Berwind-White Company's colliery, Pennsylvania, is published in the "Eng. & Min Jour.," June 1.

Proposed Power Bridge at Buffalo.—A brief account of the non-electrical features of the projected power plant of Mr. Mather is given in the "West. Elec ," June 15.

Electric Clutch.—The MacDonald clutch is described and illustrated in the "West. Elec.," June 15.

TRACTION.

Belt-line Power Station in Baltimore.—A brief paper by Dr. Duncan, read at the convention of Railway Telegraph Superintendents, is reprinted in the "Elec. Age," June 22 (this is the power house which is to supply the current for the large locomotives). It consists practically of two separate plants, one for power and one for lighting; for power there are four 10-pole generators, compound wound, of 500-kw capacity, at 700 volts, making a total capacity of about 3,000 amperes for traction purposes; the incandescent lighting is done by means of alternating currents, and there are in addition eight arc light machines for 50 lights each. The overhead conductor for the locomotives is described and illustrated; it is an iron trough composed of two bars shaped like the letter Z, and supported so as to leave a slot one inch wide between them; a trolley shoe weighing about 25 pounds passes through this slot and slides on the horizontal surfaces of the conductor bars; it is made of brass and is over two feet in length; the overhead structure is suspended by means of two sets of insulators which thus affords a double insulation and it is necessary for both insulators at a point of suspension to be defective, in order to cause a leak; the data for the locomotive is also given.

Trolley Currents and Automatic Signals.—In a brief paper by Mr. Thayer, read at the convention of the Association of Railway Telegraph Superintendents, is reprinted in the "Elec. Age," June 22; he describes a curious occurrence in Chicago on one of the trunk lines in which a block semaphore signal remained in the safety position when a rail was removed, and it was shown to be due to stray currents from neighboring trolley lines; in another case the signal would go to the danger point on the approach of a trolley car and resume the clear position after the car had passed, the trolley current being apparently of opposite polarity to the signal current; examination showed that currents whose potential varied from a half to five volts and in some cases 15 volts, were found to flow in the tracks; he states that one tenth of a volt is sufficient to hold a signal to safety when it is once up and that therefore even a small leak from a neighboring trolley line is objectionable; the only absolute remedy is the double trolley.

Transportation at the Paris Exposition.—The "St. Ry. Gaz.," June 15, publishes a map of a portion of Paris showing the location of the electric belt line which encircles the exhibition grounds, the plans of which road, it appears, have been adopted; it will be about 2.5 miles long, partly on grade and partly elevated; it is expected that electric lines leading to the exhibition will be constructed in the city.

Philadelphia.—The "St. Ry. Gaz.," June 15, begins an illustrated description of the Electric Traction Company's plant in Philadelphia.

Accumulator Traction.—A portion of the article abstracted in the Digest, June 1, is reprinted with some of the illustrations in the "West. Elec.," June 22.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Statistics for Japan.—The "Elec. Friend" (Japan) for April contains an article by Mr. Katogi, in which he gives the following statistics for the end of 1894: number of electric light companies 23, number of 8-cp incandescent lamps 106,160, number of 1,200-cp arc lamps 370; the amount of electric power used was 1,023 hp; at the end of 1892 the number of isolated plants was 51, the number of incandescent lamps of different candle-powers 20,553 and the number of arc lamps 163.

Alternating-Current Practice.—Lond. "Lightning," May 30, contains an interview with Mr. Moidey on "Press, Practices and Principles," chiefly on alternators and alternator current practice.

Three-Wire System.—"El'ty," June 19, contains an article intended to show that this system is no longer necessary, as it is claimed that other and better methods exist; these are described, although not very clearly and in some respects incorrectly. The first system is that used in Vienna and was described by Crompton in a paper read before the Institution of Electrical Engineers (London), Vol. 17, No. 72 and 73 (several years ago), the title being "Central Stations Lighting, Transformers vs. Accumulators" (those desiring a description had better consult this original description); it appears from the present abstract that the system consists in charging a number of different local groups of accumulators in series, each group being then used as an independent source of current for lighting by the usual constant potential system; the regulation of the voltage appears to be accomplished, (as is usual in accumulator systems,) by a number of cells at the end of each group, which cells are switched in and out of circuit in order to keep the voltage constant; in charging they are presumably cut out of circuit as soon as they have received their full charge; the description at present referred to, states that "in each accumulator one terminal is permanently connected to one of the discharge mains and to one of the charging mains" which evidently is incorrect as that would short circuit "each accumulator"; "the other terminal attached to the other mains can be shifted from cell to cell according to the electromotive force required in the corresponding lamp circuit." A description of another well-known system is quoted, in which a single dynamo is used to charge two groups of accumulators in series, which discharge into a three-wire system, the neutral wire being connected to their middle point.

Gas Engine Plant.—A brief, illustrated description of the plant of the Midland Railway Company, at Leicester, Eng., is published in the "West. Elec.," June 22; it is said to be the largest of its kind in England.

Steamship Plant.—A brief, illustrated description of the plant on the steamer *Northwest*, plying on the Great Lakes, is published in the "West. Elec.," June 15.

WIRES, WIRING AND CONDUITS.

Effects of Lightning Discharges on Underground Cables.—In an illustrated article by Dr. Preller, in the Lond. "Elec.," June 7, he describes the way in which the cables are laid through the St. Gothard tunnel and the way in which they are protected against lightning; he describes in detail the recent damage due to lightning and gives several explanations of the phenomenon. The tunnel is about ten miles long; at first the cables were laid in an iron channel eight feet above the rails, but this rapidly deteriorated owing to the action of the gases and water in the tunnel, and they have therefore been transferred to a trench below the tracks; the telegraph and telephone cables were protected with lightning arresters at the terminal stations of the tunnel, the telegraph cables being connected to overhead lines at the ends of the tunnel; the telephone cable is protected at both ends and is a self-contained metallic circuit in the tunnel, completely insulated from the earth, being nowhere connected to overhead wires; in the telegraph cable a fault occurred near the middle of the line and in the other quite near both ends. In the opinion of the makers of the cables there was a simultaneous discharge at both ends, with electricity of the same sign, the two waves meeting midway in the tunnel where the cable was unable to resist the maximum potentials; according to another view an oscillatory and high-tension discharge occurred at one end and its still higher tension midway in the cable coincided with a weak joint in the insulation; but neither of these explain why the arresters failed to act. Mr. Preller thinks the phenomenon was due to a weak discharge and the absence of impedance coils in combination with the lightning arresters; he believes that if the discharge had passed through the cable to the northern end the self-induction of the telegraph apparatus would probably have forced it harmlessly to earth; as to the telephone cable he believes it could be due to either a side discharge, to induction or to an indirect discharge at both ends of the cable; it by no means follows that there was a weak point in the insulation; it confirms Dr. Fleming's observations; he cites experiments by Zielinski as confirmatory evidence; from the results of more than 150 experiments with nine different arresters he prepared a table showing the mean efficiencies obtained, that is, the percentage of the discharge which was forced to earth under varying self-induction of the impedance coils; from this it is seen that even a small self-induction of 0.094 henrys sufficed in all cases to obtain an efficiency of 100 per cent., that is to force the full discharge to earth. His experiments also showed that the efficiency of the arresters was not appreciably affected by the earth-plate resistance even when this was increased to 100 ohms, that the result was probably the same whether the arrester was placed in the main or in a shunt circuit, and that the efficiency of the nine different forms varied only within very narrow limits. The company has replaced all the original lightning arresters by tinfoil safety fuses melting at ¼ to 1 ampere, and by lightning arresters composed of carbon blocks separated by a mica plate 0.3 mm thick ; he believes it to be a question whether impedance coils so placed in front of the lightning arresters as to obstruct the flow of the ordinary current as little as possible would not be preferable to safety fuses; he shows tolerably conclusively that the side-flash phenomenon is not imaginary; that with resistance values such as are generally met with in practice, a very small impedance coil effectually shunts the discharge to earth.

Multiple Cables Insulated with Ropes.—The Clouth system is illustrated and described in the "Elek. Anz.," May 19; several wires run as one cable are insulated from each other by being wound partially with ropes peculiarly knotted so as to keep the wires apart.

Conductor Materials.—Mr. Perrine's serial is continued in "Elec. Eng'ing" for June; he reprints some interesting tables deduced by a

Paris firm, showing the effects of the addition of one tenth per cent. of various metals to the copper; also tables showing the strength and conductivity of various alloys used for wires for overhead spans; he points out that while the strength and ductility are quite great the general introduction demands a far greater conductivity, strength and ductility than any of those so far investigated; the resistance of pure iron wire is given by the best authorities as 5.95 times that of an equivalent copper wire; this corresponds to 56.03 ohms per mil-foot at 0 degrees C., 4121.6 pounds per mile-ohm or 9,480 in C. G. S. units of resistance per cu. cm. He gives the results of the tests of Mr. Hamilton of some galvanized Swedish iron showing that the best galvanized iron wire used in this country has a conductivity of 96.6 per cent. for larger sizes and 97.3 per cent. for smaller sizes, as compared with that of pure iron, while the breaking strain is approximately 45,500 pounds per sq. in. of iron; an iron wire having 98 per cent. is used in England and has a weight of 4,480 pounds per mile-ohm with a tensile strength of 50,000 pounds per sq. in.; the softest qualities of Bessemer or open-hearth steel do not give better results than 5,000 and 6,000 pounds per mile-ohm with a breaking strength not much over 60,000 pounds, while cast steel of 150,000 and 200,000 pounds breaking strength has a resistance of 16 times that of copper, and weighs approximately 12,000 pounds per mile-ohm; soft steels of 5,000 pounds per mile-ohm are considerably less expensive and their strength and uniformity renders them preferable to common puddle iron which has about the same specific resistance and it is therefore customary to use such steel wire for short telegraph lines in preference to those having a better conductivity.

Danger in Flexible Cord.—In a brief article by Mr. Haskins in the "West. Elec.," June 22, he points out the dangers in the use of flexible cord, which are chiefly that very often a poor, cheap quality is used and that on account of the convenience, it is too often used in place of fixed wires.

Interior Conduit.—A long, illustrated description of the process of manufacturing, and the factory, is published in the "Elec. Eng.," June 19. The tubes are made of sheating paper which is cut into strips and wound spirally in four layers, on a mandrel, forming a tube, the overlapping part being pasted; after drying for a week it is vulcanized by being immersed for about an hour in the curing compound the basis of which is a bi-product of petroleum called petrolite, which is kept at the boiling point; it is then immersed in another vat containing a mixture (not described) which renders it alkali proof; finally it is rodded to make the bore smooth. That which is to be iron armored is passed into an iron pipe heated up to 300 degrees by steam, the tube being first immersed in a tank of hot insulating mixture; the brass-armored tubes are covered with a strip of brass the ends of which are folded together making a longitudinal lock seam which is claimed to be waterproof.

Telegraph Line Construction.—A paper by Mr. Parker read at the convention of the Association of Railway Telegraph Superintendents, is reprinted in "Elec. Age," June 27; he points out a number of difficulties encountered chiefly in mountainous regions and recommends that the best civil engineers be engaged for the construction of such lines.

ELECTRO-PHYSICS AND MAGNETISM.

Phase Shifting in Electrolysis with Alternating Currents.—The "Elek. Zeit.," June 6, contains a short article by Mr. Peukert. Froelich and Steinmetz have shown that in the alternating-current arc the phase shifting between the voltage and the current is only apparent and not real; in the present article the author endeavors to find experimentally whether the same is true in a voltameter through which an alternating current flows. A voltameter and an inductionless resistance were placed in series; an alternating current of 96 periods was sent through them, the voltage and current curves being measured and plotted; the latter, which are given, show that there is neither a change in form nor a difference in phase due to the voltameter. The experiment was made with acidulated water and platinum electrodes and was repeated with electrodes of platinum wire and with others of carbon, all of which gave the same result. It, therefore, follows that the energy consumed in a voltameter used with alternating currents is equal to the product of the current and the voltage; this was also proved by direct measurement; a result of practical importance is that resistances made of liquids may be used with alternating currents as inductionless resistances. The experiments were repeated with a voltaic arc and showed that while there is no phase shifting, the voltage curve departs very decidedly from the sine form; it rises abruptly then falls very slowly during the greater part of the period and then very rapidly.

Hall Phenomenon.—"L'Eclairage Elec.," June 1, contains an article of some length by Prof. van Aubel, in which he gives a discussion on the subject, rich in references, and describes experiments made by himself. Among his conclusions are the following: the electrolysis of nitrate of bismuth (nitrate acide de bismuth) or of the double tartrate of bismuth and potassium, give adherent deposits on an electrode consisting of a platinized mirror; the resistance of bismuth obtained from the first compound increases considerably in magnetic fields and the thin layers obtained show the Hall phenomenon very decidedly both for continuous and for alternating currents; layers made from the double tartrate do not show the Hall phenomenon; the thin plates of bismuth can be produced by the process which he gives, without difficulty and can be made much thinner than by other methods; the Hall phenomenon as observed with these thin layers of bismuth, forms a very sensitive method for measuring magnetic fields and for this purpose the E. M. F. can be measured by a capillary electrometer or by the method of Fuchs; the Hall phenomenon can also be used for measuring the component of the earth's magnetism in any direction, by using very sensitive galvanometers; bismuth does not appear to follow the law of Kundt, that the velocity of propagation of light in metals is proportional to their electric conductivities.

Vacuum Tube After-glow.—Mr. Palmer, in the Lond. "Elec.," June 7, in reply to a recent communication of Mr. Lomas (see Digest, June 1), gives references to descriptions of the phenomena in The Electrical World, Jan. 20 and Sept. 1, 1894, and states that in addition he has collected some data which he gives; the influence machine is better adapted than Ruhmkorff coil; if a 16-cp lamp be held in the hand by the bulb and the base brought near an influence machine the interior will glow and the filament will bend, gradually approaching the side of the bulb and producing the crackling discharge; if the bulb contains some loose pieces of carbon it will have great capacity and if isolated on a table it will glow for eight minutes. He concludes that if a charged body be surrounded by rarefied gas the molecules of gas will be attracted, will receive charges and be thrown off; a relatively small voltage will produce a visible glow.

Cathode and Light Rays.—A French Physical paper by Mr. Curie is abstracted briefly in the Lond. "Elec.," June 7; he describes experiments to find whether light rays were deviated by a magnetic field like cathode rays; he finds there is no deviation in 20 cm in a strong field; although he does not think these experiments are conclusive proof that cathode rays are different from those which constitute light, yet he believes they tend to show that there is some difference.

Electric Discharge Through Gases.—A Royal Institution lecture by Prof. J. J. Thomson is reprinted in the Lond. "Elec.," June 7; he describes and discusses some phenomena connected with the passage of electricity from the gas to the electrode and *vice versa* and some properties of a discharge when its course lies entirely in the gas; several of the experiments have already been described in these columns.

Sound Produced by Thermic Radiation.—The Lond. "Elec. Eng.," June 7, mentions briefly a paper by Mr. Semmola, from the "Comptus Rendus," (no date given) in which he shows that intermittent solar light focussed on the gilded metallic plate, 2 mm thick, of a Hunnings microphone, produces a distinct sound in a telephone connected with it, the intensity of which increases with the frequency, and it is greater when the plate is covered with smoke black; there is no sound when the light passes through non-thermo substances; the point of light should be hot enough to carbonize paper.

An abstract of a paper by the same author and which appears to be similar to the one from which this is taken, is published in the "Elec. Rev." (N. Y.), June 19.

Telephones and Earthquakes.—According to the Lond. "Elec. Eng.," June 7, Prof. Estrada, of Mexico, suggests the use of the telephone with a grounded return circuit for foretelling earthquakes in volcanic regions; he suggests making a microphone in the form of a pendulum suspended on a thin spiral wire so arranged as to close a magnetic circuit with the slightest motion; he proposes to connect the central observatory with the base of the volcano Popocatepetl, grounding it in one of the deepest cracks and connecting the other end with a deep artesian well. He believes that eruptions and earthquakes may thereby be foretold many days in advance.

Electric Conductivity and Convexion in Poorly Conducting Dilute Solutions.—A paper by Mr. Warburg from the "Wied. Ann.," 54, p. 396, is abstracted in the "Elek. Zeit.," June 6.

Electric Oscillation of Short Wave Length.—Prof. Righi's long serial is concluded in "L'Eclairage Elec.," May 25.

General Solution of Maxwell's Equations for an Absorbent, Homogeneous and Isotropic Method.—A paper by Mr. Berkeland from the "Comptes Rendus," 120, p. 1041, is reprinted in "L'Eclairage Elec.," May 25.

Influence of Electric Waves on the Resistance of Conductors.—"L'Eclairage Elec," May 25, contains a short note by Mr. Branly claiming priority of discovery.

Atmospheric Electricity on the Ocean.—"L'Elec.," June 28, gives a summary of a recent article by Prof. Magie, in the "American Meteorological Journal."

Magnetic Surveys of the United Kingdom.—A short paper by Prof. Rücker is reprinted in the Lond. "Elec. Eng.," June 7; he gives briefly a description of some of the results of the survey made by himself in 882 places in Great Britain and Ireland. In regard to local disturbances he found that the north pole of the needle is attracted to certain regions and lines which can be traced for even hundreds of miles, the underlying strata of which are known to be non-magnetic for great depths. Regarding the relation of the lines of disturbances to the location of the principal coal fields he states that the results do not give any countenance to the view that the magnet can be used for the discovery of coal. He shows that dykes and thin uniform basaltic sheets produce

no measureable effects except at distances from their edges which are small multiples of their thickness; isolated masses of trap-rock a few square miles in area produce no important effects at distances comparable with their dimensions; the view commonly held that faults affect the needle may in some cases have some foundation in fact.

Magnetization of Iron in Very Weak Fields.—A paper by Mr. Schmidt, in the "Wied. Ann.," No. 4, 1895, is briefly abstracted in the Lond. "Elec.," June 7, and "Phil. Mag." for June. In fields up to 0.06 C G. S. units the susceptibility for iron and steel is constant; steel follows weak forces more easily than iron; the susceptibility of soft steel in weak fields is greater than that of iron; for fields of about one unit their susceptibilities are about the same while for greater field strengths that of iron is the greater; 0.06 C. G. S. unit is the upper limit for which the susceptibility remains constant.

Magnetization of Iron Cylinders.—A second article by Mr. Grotriam, from the "Wied. Ann.," 54, p. 452, is abstracted in the "Elek. Zeit.," June 6. It has been claimed that the circular magnetization of hollow iron cylinders, as used in practice in iron-clad transformers, is not dependent upon the thickness of the iron; in the present paper he gives the results of experimental determinations made to investigate this; two hollow cylinders of the same size but different thicknesses were used, the primary and secondary coils being threaded through them; he finds that the thickness made a very great difference. He also experimented with longitudinal magnetism of hollow and solid cylinders of the same outside diameters placed in a magnetic circuit, and finds that for low degrees of saturation the flux in the magnetic circuit remains unchanged.

Influence of Magnetization on the Constant of Elasticity in Iron.—The results of researches by Mr. Bock, published in the "Wied. Ann.," No. 3, 1895, are briefly summarized in the "Phil. Mag." for June, as follows: by magnetization the constants of elasticity of soft iron, the modulus of torsion, and the modulus of elasticity are certainly not altered by more than ½ per cent.; the series of observations indicate that the flexure diminishes; at the same time the torsion seems also to diminish, while the ratio of the lateral contraction to the longitudinal expansion increases; iron is more incompressible in the magnetic field; nothing can be alleged with certainty as to magnetized steel bars.

Electromagnetic Attractive Force.—The results of some experiments given in an article by Mr. Weber, in the "Wied. Ann.," No. 1, 1895, are briefly given in the "Phil. Mag." for June. An iron wire of great length compared with its diameter, one end of which is in a magnetic field parallel to the lines of force, experiences a pull in the direction of its length, which per sq. cm of cross-section is equal to the product of I and $\mathfrak{H}$. If the lines are at right angles to the axis the attractive force at right angles to the lines of force is smaller than that just given; the ratio of the former to the latter, which, with mean strengths of $\mathfrak{H}$ equal 100, is greater than 100, rapidly decreases as the field increases and appears to approach unity.

Magnetic Strains.—The Lond. "Elec. Eng.," June 7, refers briefly to a Royal Society of Edinburgh paper by Mr. Knott and Mr. Shand on the volume changes which accompany magnetization in iron and nickel tubes.

Analogies of Magnetic and Optical Phenomena.—An article by Mr. Collischann is begun in the "Zeit. fuer Elek.," June 1; he points out analogies between polarized light and three-phase currents; it is mathematical in character.

Permeability of Russian Irons.—The "Zeit. fuer Elek.," June 1, translates from the Russian a paper by Mr. Chatelin in which he gives the results of measurements made of a number of Russian irons and steels which were determined by the Hopkinson and the Thompson methods; the permeability seems somewhat high.

Iron.—"Elec. Eng'ing" for June contains an article by Mr. Summers on the chemistry of pig iron and its application for electrical purposes; it deals chiefly with the effects of the usual impurities on the mechanical qualities, and refers briefly to their effects on the magnetic qualities.

ELECTRO-CHEMISTRY AND BATTERIES.

Bleaching Process.—A process invented by Dr. Kellner is briefly described in the Lond. "Elec. Eng.," June 7. The apparatus consists of a pair of rollers, one iron and the other carbon, between which a current is passed; the cotton cloth to be bleached is saturated with brine and runs, in company with an endless felt blanket also saturated with brine, between these rollers; the felt being in contact with the iron roller receives the caustic soda which is formed, delivering it into a tank filled with salt water; the chlorine liberated at the carbon roller accumulates in the cotton fabric which remains rolled up for some time before it is washed; whether the process has already found practical application does not appear.

Electromotive Force from Thermo-Chemical Data.—A paper read at the German Electro-Chemical Society by Mr. LeBlanc is abstracted briefly in the Lond. "Elec.," June 7. He discusses the common method of calculating the E. M. F. from known electro-chemical data as described by Thomson, and shows the objections to it; cases were discovered in which the agreement between theory and experiment was not satisfactory; he believes that it holds good only when the E. M. F. is quite independent of the temperature as in the Daniell cell and a few others-he shows how the equation can be modified so as to take into account the change of temperature.

Equivalence of Mercury and Copper in Electrolytes of Different Concentration.—An article of some length by Dr. Bolton is begun in the "Zeit. fuer Electrochem.," June 5; he describes experiments which are intended to determine whether certain salts, especially those of mercury and copper, have the tendency, in solutions of different concentrations, to form ions of different equivalence; for measuring the current he uses a mercury voltameter in preference, a description of which is given.

Helmholtz Electrochemical Theory.—The "Phil. Mag.," for June contains a short communication by Prof. Richarz in which he points out some conclusions deduced from this theory and makes some deductions regarding the electrical atom.

Researches on Polarization.—The Lond. "Elec. Rev.," June 7, abstracts briefly an article by Mr. Roszkowski, in the "Zeit. f. Phys. Chem.," 15, p. 267 and 305 describing some interesting experiments with solid and liquid cathodes.

Ozone and Nitrous Compounds—.The Lond. "Elec. Rev.," June 7, contains a short article by Mr. Andreoli in which he quotes numerous authorities regarding the production of nitrous compounds during the generation of ozone from air by means of the electric discharge. He believes that the production of nitrous compounds has been greatly exaggerated and without any ground; he has made careful researches in publications and is unable to find any experiments showing either the percentage of nitrous compounds or their noxious influence on persons breathing ozonized air; his own experiments have shown him that there is no danger in ozonized atmospheric air and he believes it may be taken for granted that if after so many years no deleterious effects have been cited, ozone is not only safe but healthful and beneficial.

Theory of Electrolysis.—The "Electrochem. Zeit." for June contains an article by Prof. Bucherer; it appears to be similar to, though not a translation of the article by the same author in THE ELECTRICAL WORLD, Feb. 2., p. 138.

Commercial Zincate of Potash by Electrolysis.—An article by Dr. Schoop, from the "Zeit. f. Elec. u. Electrochem.," 6, p. 205 and 347, is abstracted in the Lond. "Elec. Rev.," June 7; he describes a process for making this material for the Lalande primary and secondary batteries. The apparatus consists of a copper vessel with a cylinder of spongy copper within which there is a zinc cylinder resting on a layer of magnesia, which keeps the two out of contact; the liquid consists of a solution of caustic potash, is kept stirred and is heated to about 60 degrees; the copper is first made the anode after which the current is reversed; the liquid thus obtained is freed from its impurities by electrolysis in a separate vessel with zinc electrodes and a porous diaphragm of magnesia.

Baths for Nickel Plating.—The Lond. "Elec. Rev.," June 7, gives a number of baths used in German factories, all of which are said to give excellent results when they are carefully handled.

Metallurgy of Gold.—Several processes including those of Siemens & Halske, Keith, McArthur-Forest and others are briefly described in an article by Mr. Rogers in "Elec. Eng'ing" for June.

Electro-Metallurgy.—A summary of the recent paper by Mr. Moissan, mentioned in the Digest, May 25 and June 1, is published in the "West. Elec.," June 15.

Reduction of Refractory Metals.—The "West. Elec.," June 15, reprints an abstract of Prof. Roberts-Austen's lecture mentioned in the Digest, June 8.

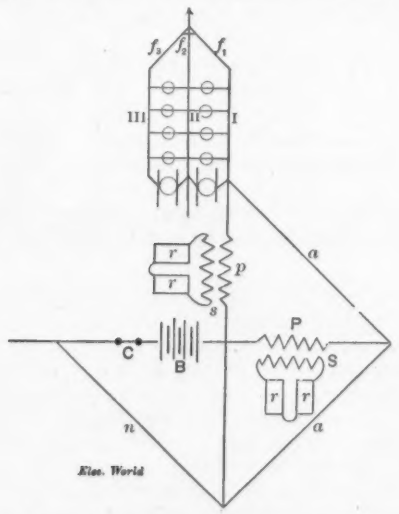
UNITS, MEASUREMENTS AND INSTRUMENTS.

Measuring the Mean Spherical Intensity of Sources of Light.—The article by Prof. Blondel, mentioned in the Digest, April 13 and May 18, is continued in "L'Eclairage Elec.," June 1; he discusses three new methods for replacing the tracing of the photometric curve by a single operation; they all depend on the same principle; the light is placed at the centre of an opaque sphere having one or more openings through which a definite fraction of the total flux of light passes and which is then concentrated at a single point by apparatus which he calls lumen-meters, the difference between these constituting the difference in the methods. After discussing the properties of diffusion by transmission and reflection he describes and gives the theory of the various methods; in one of these a reflector is placed behind the light embracing a certain fractional part of all the rays emitted by the light, and directs them on to a translucent screen, the direct rays being prevented from reaching the screen; the light on the opposite side of this screen is then measured by a photometer and is a measure of that part of the total flux of light which is intercepted by the mirror; the reflector may for simplicity embrace all the light which passes on one side of a plane through the source, that is, just one half of the flux, and instead of passing it through a translucent screen it may be thrown on a white diffusing surface the illumination of which is then measured by a photometer; in practice these methods are exact only if the loss in each of the reflected rays

is the same, but this is not the case; in practice the only reflector which can be used is one made of silvered glass; to climate the error due to the different losses in the reflection of the different rays, he devised the lumen-meter which was described in the Digest, April 13 (see also May 4 and June 8), and in which only a zone of rays is reflected, the angles of incidents of which are nearly constant for all the rays.

Lumen-meters for Measuring Luminous Flux.—An interesting paper by Mr. Ray is reprinted in the "Bul. Soc. Int. des Elec." for May, being devoted to the measurement of mean spherical illumination in general and in particular to the ingenious instrument of Prof. Blondel mentioned in the abstract above. He calls attention to the importance of being able to measure the total luminous flux, or quantity of light, as it is sometimes incorrectly called; the value of the total flux is an important quantity to know in dealing with the illumination of a light in a closed space or room; the usual method is to measure the light in different directions and plot the curve, from which the total flux is then calculated; in the method of Prof. Blondel the mean illumination in a number of different directions represent a definite fraction of the whole surrounding spherical surface, and is measured in one operation; the mirror used in the above-mentioned apparatus is a zone of an ellipse and its surface represents one tenth of that of the whole surrounding sphere; the total flux is therefore 10 times that measured; with this instrument he finds that one lumen will be equivalent to about 0.003 cp on the screen; the total flux in lumens, of an arc light for different currents and carbons, is given, that for 10 amperes, 43 volts with carbons 21 and 13 mm in diameter is 6,660 lumens, and for the same lamp with six amperes it is 1,000, while with 30 amperes it is 16,260. Several photographic reproductions are given of the luminous spots on the screen. In conclusion he describes a much cheaper apparatus in which the expensive mirror is replaced by a frustrum of a cone whose apex has an angle of 100 degrees, the inside surface being covered with a white paper having a dull surface; this takes the place of both the reflector and the diffuser, the light from it being measured directly by the photometer; the opaque sphere, surrounding all but a definite portion of the space around the source, is used as before; the illumination measured by the photometer under these conditions is approximately proportional to the flux measured; the apparatus is naturally much less exact than the preceding one, but it can be used to great advantage in practice. He also suggests the use of a zone of a parabolic mirror.

Measuring the Insulation Resistance of an Installation While Running.—The "Elek. Zeit.," June 6, reprints a long paper by Dr. Froelich in which he gives a mathematical discussion of the Wheatstone bridge when not balanced, and of ohm-meters, concluding with a description accompanied by illustrations, of the apparatus and of a method of measuring the insulation resistance by means of an instrument which gives the value directly. The ohm-meter used is the usual type in which there are two coils perpendicular to each other, acting on an iron needle, one of them generating the directing field and the other the deflecting field; when the installation is not in use this instrument may be used directly; when the installation is in use the arrangement shown in the adjoining figure is used; it is a Wheastone bridge arrangement in



which the fault forms one of the branches, the two other branches *a* and *a* are equal while the fourth *n* is made 1, 10, 100, etc., ohms; one of the diagonals contains the battery, *B* the contact *C*, and an induction apparatus *P* the coils *rr* of which form the directing coils of the ohm-meter; the other diagonal contains a similar induction apparatus the coils of which form the deflecting coils of the instrument; a different scale must be used for each resistance inserted in the branch *n*; the contact *C* must be periodically opened and closed in such a way that the circuits of the battery branch and that of the other branch are opened and closed alternately and not simultaneously (from this it appears that there ought to have been another contact in the other diagonal; the description is not as clear as might be desired); this contact is operated by an electric motor running at constant speed; the induction apparatus in the battery circuit may be omitted. It appears that variations in the voltage of the lighting circuit affects the results quite materially, but in the large station in Berlin these variations were not important. He enumerates the following as the novelties in this method: The insertions of the directing coils of an ohm-meter in one of the diagonals of a Wheatstone bridge and the deflecting coil in the other when there are no E. M. F's. in that circuit whose resistance is to be measured; and the measurement of this resistance by means of the "ratio of the variations of the current in the two diagonal branches in combination with an induction apparatus and a galvanometer with two coils perpendicular to each other," when there are E. M. F's. in the circuit to be measured.

Electrical Inspector's Laboratory.—The English journals, June 7, contain illustrated descriptions of the laboratory of the Electrical Inspector to the City Commissioners of Sewers; the most complete description and the one containing the best illustrations is that in the Lond. "Elec. Rev."; the duties of this inspector are published in the Lond. "Elec. Eng."; those for which the laboratory is required are chiefly the calibration of volt, ampere and supplying meters. For alternating-current work there is a special transformer connected with the street mains, having three secondary windings two of which can be made to increase the voltage by two-volt steps; Kelvin balances are used, also Ferranti non-inductive resistances, illustrations of which are given, which enable the current to be regulated by tenths of an ampere up to 500 amperes; they are made of five vertical copper rods surrounded concentrically by German silver wires of different lengths, dipping into mercury cups at the bottom, which can be raised or lowered by hand, connecting these resistances in multiple.

Electrical Measurement of Starlight.—An abstract of a preliminary report to the Royal Society by Prof. Minchin is published in the Lond. "Elec.," June 7. He describes the method used for measuring the intensity of light from stars and planets which consists in the determination of the E. M. F. generated by this light in certain photo-electric cells, the square of this E. M. F. being proportional to the energy of the light; the surface of these cells is formed by depositing a thin layer of selenium on a surface of clean aluminum and immersing this in oenanthol; the seat of the E. M. F. is the contact surface of the liquid and the selenium, the latter receiving a positive and the former a negative charge; the experiments are said to prove conclusively that there is little difficulty in obtaining fairly accurate measurements of the light of stars of the first and second magnitudes even without a large telescope; there appears to be a surprising agreement between the photo-electric and the photo-metric determinations of the magnitude of a star.

Standard Resistances for Strong Currents.—The "Elek. Zeit.," June 6, reprints in full with illustrations a short paper by Dr. Feussner describing the new standard resistances of the Reichanstaldt for measuring large currents at the terminals of a known resistance, an abstract of which appears in another column.

Measurement of Temperatures by Thermo-electric Couples.—An article of some length by Messrs. Van Aubel and Paillot is reprinted in "L'Eclairage Elec.," May 25. It describes experiments made with constantan couples by the Fuchs method; their conclusions are that the E. M. F. of a constantan-iron couple is 53.86 microvolts per degree centigrade between 0 degrees and 98.9; this couple is preferable to others as it can be used to measure the temperature at a small point when great sensitiveness is necessary; the curve of the E. M. F's. approaches very closely to a straight line and between certain points it can be considered as such.

Lecture Apparatus.—A simple and ingenious apparatus is described and illustrated in the "Zeit. fuer Elek.," June 1; it consists of a diagrammatic drawing of a dynamo with spaces occupied by the wires and commutator cut-out, behind which rotate discs so arranged as to give an optical imitation of the flow of the current; the description is somewhat incomplete.

Measuring Magnetic Fields.—See above under "Hall Phenomenon."

TELEGRAPHY, TELEPHONY AND SIGNALS.

Fac-simile Multiplex Telegraphy.—A recent paper by Dr. Cerebotanti is briefly abstracted in the "Elek. Zeit.," June 6. He describes a fac-simile telegraph based on right-angular co-ordinates with the introduction of two polarized relays in the receiver, with a common elbow-joint lever operated by a variation in the intensity of the current by means of which the third wire, which in the Gray telautograph is required for raising and lowering the pen, is therefore rendered unnecessary. He also described an ingenious combination of local circuits with relays at the transmitter, which avoids sending the currents for the two co-ordinates simultaneously and which enables them to be sent successively thereby obtaining a means of operating a fac-simile telegraph with only one wire. He also described a Morse quadruplex telegraph without synchronism, the main factor of which is an interrupter at the sending station, whose object is to interrupt the sending currents which vary in direction and strength so that one impulse follows the other in the form of four alternating impulses, thus necessitating the use of only a single wire. This is practically all the information given in the abstract. In the discussion Mr. Bieringer expressed the belief that there was nothing gained in using variations

in the current strength in place of a synchronous apparatus, as experience has shown that apparatus depending on current variations are greatly affected by the insulation resistance of long lines.

Telephone Installation in Stuttgart.—The "Elek. Zeit.," June 6, contains the first part of a long and well-illustrated description by Mr. West, of the station in Stuttgart, including a number of illustrations of the details; the installation was completed in April, 1894.

Telephone Switchboard for Central Station.—A well-illustrated description of one made by Naglo in Germany, is published in the "Elek. Zeit.," June 6.

Telephone Switches Used in Antwerp.—An illustrated description is published in "L'Eclairage Elec.," May 25.

Accumulators in Telegraphy.—A paper on "Electrical Accumulators," by Mr. Stewart, read at the convention of the Association of Railway Telegraph Superintendents is reprinted in the "Elec. Age," June 22. He describes briefly the plant at the New York terminal of a railroad in which 72 accumulators were substituted for 238 gravity cells, 70 of the cells, having a capacity of 12.5 ampere-hours, are for working the lines, and two of 150 ampere-hours for the local circuits consisting of 21 sounders; the cost of maintaining the gravity cells for one year was more than enough to purchase the storage battery plant; it seems to be working very satisfactorily. In conclusion he refers briefly to the use of accumulators in lighting and for trolley lines.

Relative Cost of Telephone Service to the User..—"Elec. Eng'ing" for June contains an article by Mr. Deland in which he discusses in detail the relative cost of the service in large and small exchanges. In large exchanges about 100 times as many subscribers are reached and about 10 times as much service is actually rendered; in a town having 100 to 200 subscribers about one mile of line is used when two subscribers are talking while in Chicago the average length of line actually used for each conversation is nearly four miles.

Sound-Amplifying Telephone.—The Nikolajczuk system is described and illustrated in the "Elec. Rev.," June 19; it appears to consist of a sort of telephone relay; the transmitter currents "vary the internal resistance of a separate source of electricity, which in turn transforms the current variations into telephonic vibrations"; it appears to be an adaptation of Mr. A. G. Bell's original liquid transmitter to operate as a relay.

MISCELLANEOUS.

Influence of Telephone Wires on Atmospheric Electricity.—From a brief note in "L'Elec.," June 8, and "L'Eclairage Elec.," May 25, the German government telegraph department have collected some statistics in order to determine the influence of networks of telephone wires in cities on the atmospheric electricity, in order to find out whether the dangers from lightning are increased or diminished; the results showed that the presence of telephone wires tends to diminish the "violence of the thunder" (*sic*) and to diminish the dangers from lightning; in 340 cities there were telephone wires and in 560 there were none; in these two cases the damage done by lightning varied in the proportion of 1 to 4.6; the mean number of lightning discharges per hour of storm, was five for the villages without telephone wires and three for the others.

Mechanical Principles of Electrical Engineering.—A long address by Mr. Ransom is reprinted in the Lond. "Elec. Eng.," beginning with June 1; he recommends electrical engineers to give adequate attention to the principles of mechanical engineering; most of the present portion is devoted to a discussion of iron from the mechanical engineer's standpoint, an elementary discussion of the transformation of energy, the testing of some engines and boilers, and to refuse destructors; regarding the latter he says it may be fair to assume that the average refuse in English towns can never evaporate as much as 3.5 pounds of water per pound of refuse; for poorer refuse he gives 1.1 pound of water as the average.

Electric Organs.—A brief description of the one used in St. George's church in London is given in the Lond. " Elec. Eng.," June 7.

Vulcanized India Rubber.—The specifications for the Russian navy are published in the "Zeit. fuer Elek.," June 1.

Tubular Poles.—A form of composite pole made in Germany, consisting of iron tubes and resembling those used in this country, is illustrated and described in "L'Elec.," June 8.

Royal Society Transactions.—The catalogue mentioned in the Digest last week appears with the issue of the "Phil. Mag." for June.

Electric Organ.—An illustrated description of the one used in Steinway Hall, Chicago, is published in "West. Elec.," June 22.

Electric Railways in Japan.

Russia is just now placing large shipbuilding and machinery orders in France; but Japan does not seem to recognize help from Great Britain in a similarly substantial manner, for German papers announce that the Allgemeine Elektricitäts-Gesellschaft has received a commission from Tokio for electric railway material to the value of several thousands of pounds, and the placing of a second large contract with the same firm is reported as pending.

Zickler's Universal Electrodynamometer.

In a letter to the London *Electrician* Mr. Karl Zickler discusses the subject of electrodynamometers in reply to a criticism on an instrument devised by himself. Referring to the conditions which an instrument for measuring potential has to fulfill, and which have to be considered in the construction of the same, he says they are comparatively easy to comply with when the instrument is only intended for measuring potential. In the case of the electrodynamometer here considered, however, the conditions take the following form: If, first of all, mirror-reading is supposed, then the watt loss and the influence of the self-inductance can be made very small. In direct-reading electrodynamometers, torsion electrodynamometers and electrodynamic current weighers, it is easily possible to bring the maximum watt loss down to about 0.1 watt for every volt of the potential to be measured. As an instance of this is mentioned the centi-ampere balance of Lord Kelvin, when used as a voltmeter. Again, the influence of self-inductance in potential measurements of alternating currents can, with medium periodicity, be easily confined to a small percentage of the potential to be measured. An instance of this is the astatic potential dynamometer of Siemens and Halske, which, with alternating currents of 50 to 80 periods per second, show only 2 to 3 per cent. difference in the readings for continuous and alternating currents.

Considerably greater difficulties are caused in this direction when it is required to construct an instrument which, besides potential measurements, also permits of measuring current and electric power (watts) between very wide limits. One is generally obliged to make larger concessions with regard to watt loss and the influence of self-induction. In the composite balance of Lord Kelvin, which serves for current, potential and watt measurements of continuous current, there is a maximum watt loss of 0.5 watt for every volt of the potential, though this instrument has no conductor for large currents in the movable coil, but requires an auxiliary current to be taken through the movable coil when measuring big currents.

The result attained by the Zickler instrument of a maximum loss of 0.4 watt per volt of the potential is therefore better than the result of the above-mentioned universal instrument, the more so when one considers that even the biggest currents are conducted through the movable coil, and no auxiliary current is required.

The most unfavorable feature in the universal instrument, as compared with a simple potential electrodynamometer, is the greater weight of the movable coil, which consists of a copper frame of 35 square millimetres, and 60 turns of a wire 1.2 millimetres thick. This requires, in order to attain a certain sensibility, a powerful spring, and therewith likewise the turning moment is settled, which the current-carrying coil has to exercise upon the movable coil. Having settled upon a suitable maximum for the voltmeter current, then the product $m_1 \times m_2$ of the number of turns of the fixed and movable coils will have a certain value. Theoretically speaking, then, other conditions being the same, the self-inductance of the coils is smallest when the sum of the turns m_1+m_2 is a minimum. This is the case when $m_1=m_2$. To get near this favorable point in practice without increasing the weight of the movable coil, the same can be made of *aluminium* instead of copper. An instrument of this kind is in course of construction, and, owing to the increase of windings of the movable coil and the decrease of the windings of the fixed coil, more favorable results in potential measurements of alternating current in respect to self-inductance will be arrived at, so that, for instance, at the same torsion angle the variation between the readings for a continuous current (600 volts) and alternating current at 100 periods should no longer be 50 per cent. (900 volts), but only 2 to 3 per cent. At the same time the watt loss in the instrument will become smaller. In future, therefore, all instruments will be so constructed that the influence of self-inductance and the watt loss of the instrument will be confined within the desirable limits. This universal instrument should therefore be of great service to electricians in all those cases, which often occur, where no suitable instrument for the special measurement in hand is at their disposal.

French Submarine Cables.

A despatch from Paris on the 7th inst. says that strenuous efforts are being made by the French colonial party to force the government to introduce an extensive system of submarine cables, in order to avoid having to depend upon the English lines in case of war, a necessity which is declared to be a great national danger. It is now stated that considerable opposition will be offered before the budget committee to the renewal of the subventions paid to the English cable companies, of which the principal are the Spanish Submarine Telegraph Company, 1,700,000 francs a year for the cable to Senegal; the Eastern Extension Company for Saigon and Tonquin 300,000 francs, the African Direct Telegraph Company for the west coast of Africa 300,000 francs, and the Eastern Telegraph Company, the short line from Obock to Berlin, 37,500 francs. It is contended that this money should be devoted to founding French cable companies.

Enamel Rheostats.

Some new motor-starting rheostats have recently been put on the market by the Carpenter Enamel Rheostat Company, of Hoboken, N. J., which contain some very meritorious features. One type, known as spring starting rheostats, are so made that the contact lever cannot be left by the operator upon any intermediate contact. In addition to this feature of protection against burning out the rheostat, a recent invention of Mr. H. Ward Leonard is introduced, by which, while all the current needed for the motor can be secured, it is impossible for an excessive current to flow through the rheostat, which so frequently occurs with such devices in the hands of unskilled or careless operators. The Carpenter Company claims that it is practically impossible to burn out the new spring starters except by deliberately trying to do so.

A second type of rheostat just marketed by the company is the Leonard automatic rheostat. This rheostat is so constructed that if, from any cause, the current through the motor exceeds a certain predetermined amount, the circuit is instantly opened by a light, quick-moving snap switch. This affords a perfect protection against overload under any and all conditions. The most familiar causes of burn out which this prevents are the cutting out of resistance too rapidly, and a resulting rush of current through the motor; the application of too great a load when the motor is running, and the interruption of the central-station current followed quickly by a resumption of service after motor has come to rest. It is claimed to be impossible to do any harm to either the motor or rheostat under any of these conditions. The arrangement is such that after the safety device has operated and opened the circuit it is necessary to insert *all* the resistance of the rheostat before the circuit can be again closed through the motor or rheostat.

A third style of rheostat the Carpenter Company is offering is the Ball automatic rheostat. In this device, if the current fails, the circuit is instantly opened without inserting the resistance. Then the resistance must be inserted by hand before the motor can receive any current. The controlling magnet for this rheostat is not in series with any part of the motor, and hence has no effect upon its speed or efficiency as former similar types have had.

Electric Lighting in the Orient.

The new electric light station being erected at Shanghai, China, by the municipal council has been designed to combine a striking exterior with internal adaptability to the purposes for which the edifice is intended, being similar to the new electric light station at Cleveland, O. The building throughout is constructed of blue and red brick, and the engine house measures 116 feet in length by 35 feet in breadth, and 25 feet in height. The chimney is 130 feet high, with an internal diameter of 7 feet.

It is intended to install no fewer than 14 compound-horizontal surface-condensing engines. The dynamos for arc lighting are by the Brush Company, of Cleveland, O., and the alternators, switches, transformers and such instruments are the work of the Brush Company, of England. The boiler house will contain three Lancashire boilers, each measuring 7 feet by 28 feet, and capable of sustaining a working pressure of 140 pounds. There will also be two locomotive boilers working at the same pressure.

In the City of Manila, Phillippine Islands, a large new electric light station has just been completed, all the work here being done by the Brush Company, of Cleveland.

Automatic Telephone Exchange.

An interesting demonstration of the perfected automatic telephone exchange system invented by Mr. Romaine Callender is being given daily at the Decker Building, Union Square, New York. The system has been considerably simplified since its description in THE ELECTRICAL WORLD last January, the numeralizers and numerical separators having been abolished, and their functions combined and performed by the numerical receivers. Broadly, the system comprises signaling apparatus at each subscriber's station by which the number desired is set in to the central station, where it is registered by an instrument designated as the numerical receiver. A circuit selector then makes connection between the calling circuit and the circuit whose number has been sent in, and signals both sub-stations. When conversation is finished a clearing-out signal is sent in by either subscriber, and the circuit selector restores both lines to their original condition.

The system is a percentage one, cross-connections and numerical receivers being furnished for 10 per cent. of the total number of subscribers, which statistics show to be about the maximum proportion of telephone exchange circuits that are in use simultaneously. The arrangement is exceedingly ingenious, and was operated repeatedly on last Thursday with unvarying accuracy.

Electric Lights in Dutch Guiana.

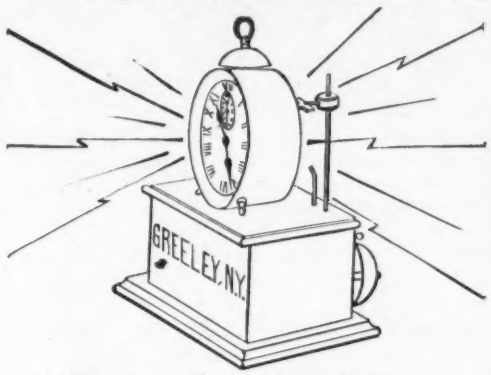
The local authorities of Paramaribo have been approached by a company with a scheme for the electric lighting of the town, and a committee appointed to inquire into the matter has decided in favor of electricity.

Some New Specialties.

Electric alarm clocks have now become quite as common as the ordinary mechanical alarm clock was formerly. Owing to the fact, however, that the cheap popular clock of the so-called "nutmeg" pattern is liable to serious derangement by any attempt to provide for electrical contacts in its works, attempts have been made to produce a device that could be used in connection with any of the various styles of circular alarm clocks now on the market without any attempt to make electrical connections thereon, and this seems to have been accomplished by an inventor who has put his work into the hands of The E. S. Greeley & Company, 5 and 7 Dey Street, New York, who are now manufacturing it.

The device consists simply of an ornamental battery box provided with an electric bell and a time ball. The time ball is hung upon the alarm key of the clock, the turning of which upon release of the alarm drops the ball and completes the circuit, the bell continuing to ring until the ball is raised. The accompanying cut fairly illustrates the attachment.

The waterproof lamp socket shown in the accompanying illustration has



ELECTRIC CLOCK ATTACHMENT.

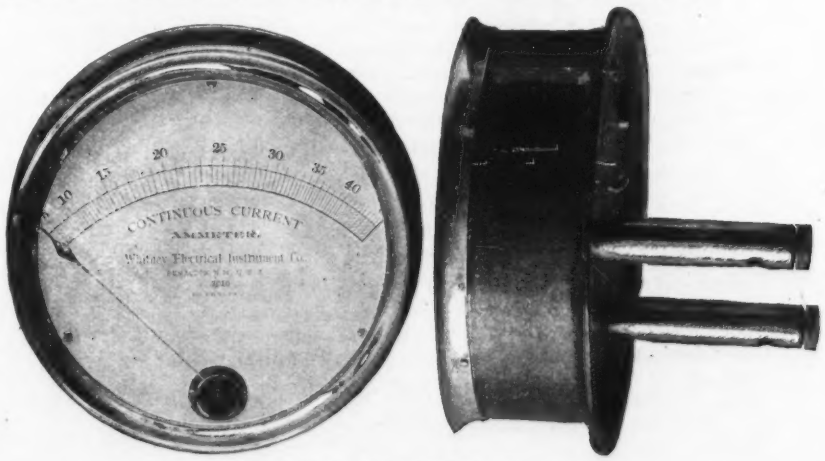
INSULATED WALL SOCKET.

been recently put on the market by the Fiberite Company, of Mechanicsville, N. J., for whom The E. S. Greeley & Company is New York agent. The insulating material is the well-known Medbery composition, and is pressed in shape around the metal parts under enormous pressure, so that moisture cannot penetrate between the binding posts and the insulating body. For outdoor work such as illuminated signs, store-front decoration, etc., these sockets are especially suitable, and they are also useful for work in breweries and other damp interiors. The sockets are furnished to fit any of the standard lamp bases.

New Iron-clad Volt and Ampere Meters.

We illustrate herewith the most recent production of the Whitney Electrical Instrument Company, Penacook, N. H., in the way of switch board ammeters for direct currents. As will be seen from the engraving, the instrument is of the familiar circular-case form which has become so generally liked throughout the trade, and it is provided with rear lugs for connecting behind the board.

These instruments are guaranteed accurate within 1 per cent., and are encased in iron so as to obviate interference from extraneous sources and to allow the instruments to be placed as near each other as may be



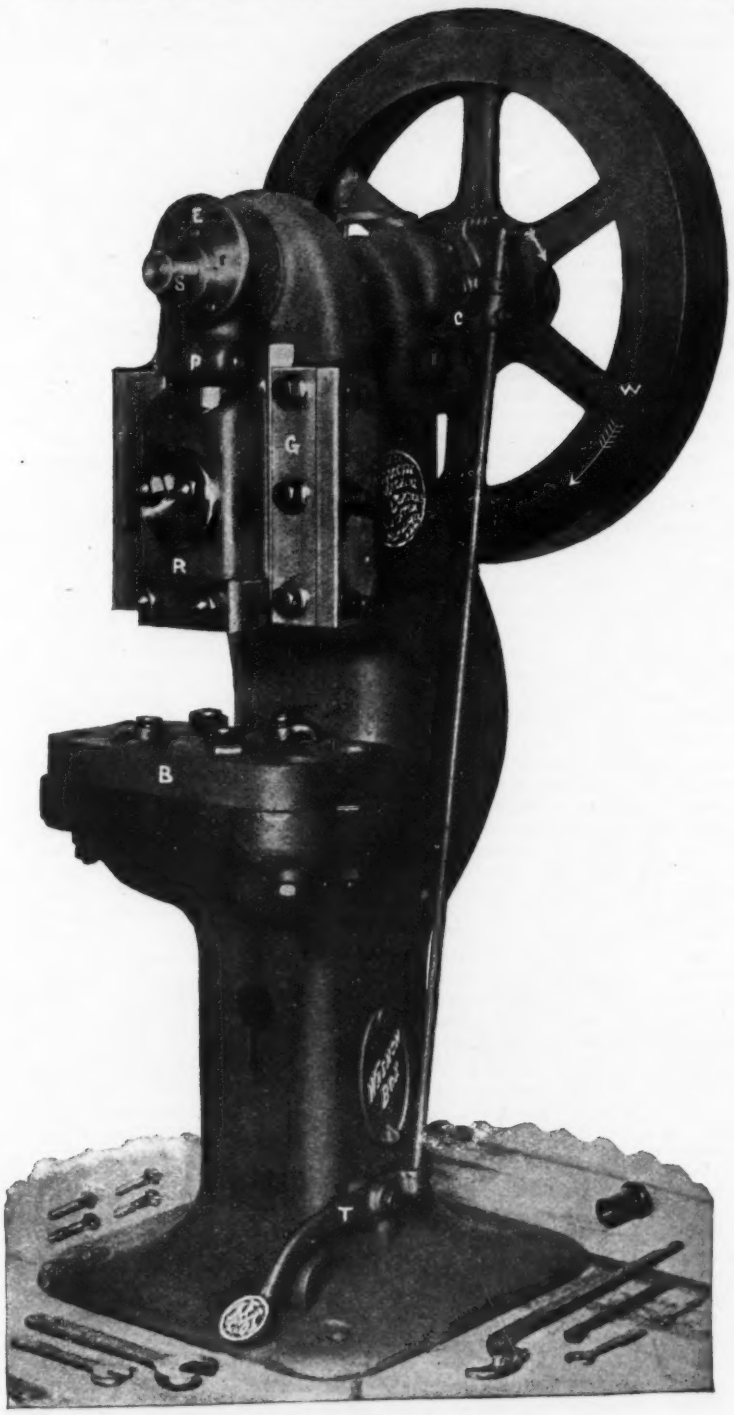
IRON-CLAD AMMETER.

desired without exerting mutual influence. They are handsomely finished in black enamel with nickel trimmings, and fully come up, in design, workmanship and material, to the high standard characteristic of the product of this company. The voltmeter is identical, in principle and appearance, with the ammeter, both being designed to meet the great demand for an inexpensive yet reasonably accurate and wholly reliable instrument for switchboard service.

Power Presses at the Westinghouse Works.

Among the special machine tools which the Westinghouse Electric & Manufacturing Company have had furnished for its new plant at Brinton may be mentioned a heavy power embossing press built by the Ferracute Machine Company, of Bridgeton, New Jersey. This machine is made unusually wide and high to suit the purposes for which it is used. Two vertical columns rising from either side of the bed take the tensile strains, each column being six by nine inches in section, and the two being capable of withstanding a stress of some two or three million pounds.

This company has also furnished a number of its regular presses, there being eight new cutting presses in use. These presses have large beds, and are adapted for cutting and forming sheet metal work in great variety but are especially useful in cutting and punching such work as armature discs and other sheet metal parts of electrical goods which are comparatively thin but have large area. These machines can be used either upright or inclined, the centre of oscillation being so placed as to keep the centre of the dies at approximately the same height, whatever the inclination of the press. The distance from bed to ram is unusually high, and the adjustment of the ram is about double what it is on other styles of presses, thus allowing considerable variety in the height of dies. The heads of the bolts which hold the bolster to bed of press are sunk into the bolster, thus giving a wide flush surface on which to rest the lower dies. These presses will cut and form rectangular sheets 10 by 14 inches in size, or round ones 14 inches in diameter.



HEAVY PUNCHING PRESS.

Several punching presses are also in use in the Westinghouse Works, one of which is shown by the accompanying engraving. As the metal to be handled by these presses is thicker than sheet iron, and as the work is usually of small diameter, the depth of throat and width of bed is less than is the case with cutting presses while the general construction is heavier. The design in regard to correct proportion and symmetrical appearance speaks for itself, the metal being put where it will give the most strength for the least weight, and the harmony of proportion being secured by unbroken surfaces, flowing curves and heavily rounded corners. The motion is conveyed to the ram *R*, by a pitman, *P*, with a graduated threaded rod passing through the fulcrum pin, while the connection with the shaft *S* is by means of an eccentric, *E*. Other eccentrics giving a greater or less stroke can be substituted when desired. One of these punching presses has been equipped with an indexing attachment adapted for automatically punching the notches on the periphery of motor discs, the machine being designed to take in any diameter and punch any number of notches up to a certain limit.

All of the Ferracute presses have automatic clutches with tripping devices adjustable around the axis of the shaft and arranged so that the shaft cannot make more than one revolution by one action of the treadle. The fly wheel contains several steel jaws so that the operator only has to wait a portion of a revolution for the clutch to act when the treadle has been depressed, the time thus saved being quite considerable in the course of a day.

Improved Watch-Form Telephone Case.

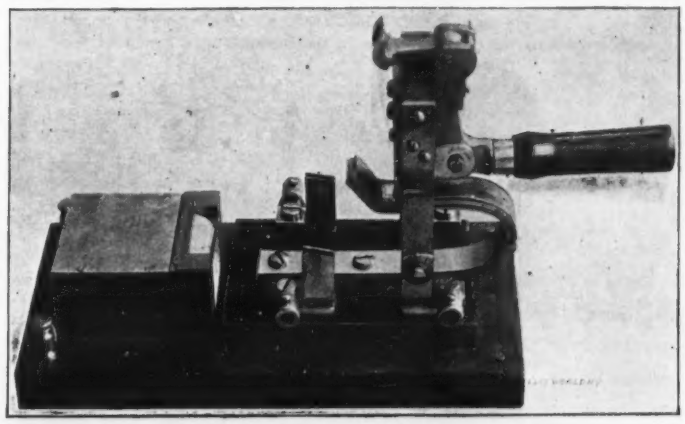
The accompanying engraving shows a new telephone receiver case, of the watch case type, which is being placed on the market by the Electrose Manufacturing Company, 214-218 William Street, New York. While the general shape and design of the receiver case are not novel, there are several meritorious features embodied in its construction which are worthy of consideration. The cap of the case is so shaped as to fit over the ear perfectly, so as to exclude all foreign sounds. Another improvement consists of an almost imperceptible beveling of the rim of the case upon which the diaphragm rests, the outer edge being the slightest bit higher than the inner edge of the rim, so that the diaphragm is clamped firmly at its outer edge and without any buckling tendency. The inner face of the cap where it clamps the diaphragm is ground perfectly smooth and true so as to contribute to the result just mentioned.

TELEPHONE SHELL.

The material of which the case is constructed—Electrose—is peculiarly suitable for this purpose in that it is impervious to moisture, and, therefore, cannot warp or swell and thus alter the inter-relation of the various parts.

An Emergency Switch.

An ingenious application of the familiar electric door-opener principle is embodied in the emergency switch herewith illustrated, which is manufactured by Edwards & Co., at 144th Street and Fourth Avenue, New York. The cut is practically self-explanatory. A strong spring constantly tends to open the switch, which, when closed, is held by a spring latch. This latch is adapted to be withdrawn by a magnet whose circuit may be controlled by a push button or switch located at any desired point—near the generator or engine, for instance—so that in case of trouble the circuit which the switch controls may be instantly opened without taking time to get to the switchboard. Numerous applications will suggest themselves to all engineers who are familiar with the exigencies frequently arising in the operation of electrical installations.



EMERGENCY SWITCH.

NEWS OF THE WEEK

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

ELECTRICAL STOCKS appear to have anticipated the regulation summer apathy by about 30 days, the entire list being practically devoid of life or interest.

EDISON ELECTRIC ILLUMINATING, of Brooklyn, on Wednesday held a special stockholders' meeting and increased its capital stock to $8,750,000. The directors were authorized to issue $500,000 additional bonds for the purchase of the Citizens' Company's capital stock and making extension.

AMERICAN BELL has remained almost stationary notwithstanding a faint effort to make capital of the retirement of certain Western Union people from the Philadelphia directorate by suggesting that this move was preliminary to the wholesale entry of the Bell Company into telegraph work. The true inwardness of the matter, as given by high authority, is that the American Bell Company bought a controlling interest in the Philadelphia local company, among the holdings transferred being some which the Western Union parties had previously controlled.

BALTIMORE TRACTION continues strong above 20. While the reported deal between this company and the City & Suburban Company, of Baltimore, is not an accomplished fact, there was some ground for the rumor, though President Brown said not—in a perfunctory kind of way. The consolidation was suggested by certain City & Suburban interests, though no specific proposition has been made, and the prevailing opinion in traction circles is that the consummation of the deal depends only upon the terms which may be proposed.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked.
Chicago Edison Company	100	120	125
Edison Electric Ill., New York	100	101	101¾
" " " Brooklyn	100	..	108
" " " Boston	100	129	130
" " " Philadelphia	100	..	115
Edison Ore Milling	100	13	15
Electric Storage Co., Philadelphia	100	29	30
General Electric	100	35⅞	36
General Electric, pref	100	..	65
Westinghouse Consolidated, com.	50	36	36½
" " pref	50	52⅜	..

BONDS.

Edison Electric Ill., New York	100	105⅛	105¼
Edison Electric Light of Europe	100	75	85
General Electric Co. deb. 5s	100	..	90¼

TELEGRAPH AND TELEPHONE.

American Bell Telephone	100	..	205
American District Telegraph	100	30	40
American Telegraph & Cable	100	96	..
Central & South American Telegraph	100	117	120
Commercial Cables	100	159	..
†Erie Telephone	100	58	58½
Gold & Stock Telegraph	100	105	..
New England Telephone	100	74	74¼
New York & New Jersey Telephone	100	103	105
Postal Telegraph-Cable	100	63⅛	..
Western Union Telegraph	100	92	93⅛

ELECTRIC TRACTION STOCKS.

Baltimore Traction	25	20⅝	20⅞
Binghamton RR. com	100	100	..
Brooklyn Traction	100	15	16
" " pref.	100	..	53
Buffalo St. Ry	100	84	91
Cleveland City Ry	100	68	70
Cleveland Electric Ry	100	59	60
Chicago City Ry	100	305	315
Columbus St. Ry	100	48⅛	..
Consolidated Traction of N. J.	..	26	30
Electric Traction, Philadelphia	50	..	75
Hestonville	100	58	58⅞
Long Island Traction	100	12¾	13¼
Louisville St. Ry. com.	100	37	39
" " " pref.	100	87	88
New Orleans Traction	100	20	22½
" pref.	100	69	71½
North Shore Traction	100	28	32
" " pref.	100	81½	86
People's Traction $30 pd.	25	61⅝	61⅞
Philadelphia Traction	50	83⅛	83½
Rochester St. Ry	..	38	..
Union Ry. (Huckleberry)	100	112	115
West End, Boston	100	71¼	72
" " pref	100	..	92
Worcester Traction	100	17	19
" " pref	100	83	87

BONDS.

Buffalo St. Ry. 1st con. 5s	100	106	108
*Binghamton Railroad Co. 5s	100	99	100
*Columbus St. Ry. 1st 5s	100	104	..
Rochester St. Ry. 1st. 5s	100	95	97
*Union Ry. 1st. mtge 6s	100	105	108
*Westchester Electric 1st. mtge. 5s	100	98	101

* With accrued interest.
† Ex-Div.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
253 BROADWAY, NEW YORK, June 24, 1895.

STOCKHOLDERS' MEETING.—A meeting of the stockholders of the Electric Illuminating & Power Company, of Long Island City, has been appointed for July 1, for the purpose of increasing the capital stock from $50,000 to $150,000.

LIGHTS FOR OCEAN BOULEVARD.—The Brooklyn aldermen have decided to put electric lights on Ocean Boulevard from Prospect Park to Coney Island, and voted last week to make a contract for the lights for a term of three years. The lights will greatly reduce the danger attendant upon traveling the boulevard after dark.

TROLLEY CAR TOOK A HEADER.—Mount Vernon trolley car 102, while traveling at the rate of 12 miles an hour Friday night, jumped the track, and, striking a trolley pole, took a header into a ditch where it stood on end. The passengers were shaken up, and the conductor lost a pocketful of change. No one was badly hurt. It is said that the switch was tampered with by residents who oppose a trolley line.

NANTASKET'S ELECTRIC LINE.—The test of an electric locomotive last Friday night on the Nantasket Beach branch of the New York, New Haven & Hartford Railway has caused quite a ripple of excitement in railway circles, and premature suggestions are rife concerning the abolition of steam on the main lines, and kindred absurdities. The test was thoroughly satisfactory, the speed attained being estimated at 60 miles an hour, and the control of the motor car being complete and reliable. The car was equipped with the Westinghouse air brake, and all the standard appliances now in vogue.

OVERHEAD WIRES IN WALL STREET.—The District Attorney was requested last week by Amos J. Cummings and Col. Henry S. Kearney, of the Board of Electrical Control, to lay before the Grand Jury the proceedings of several persons who are violating the subway law by stringing private wires overhead in and around Wall Street connecting brokers' offices. The wire use is very small copper wire, covered with dark green silk, which makes it almost invisible from the street. The wires are put in for $15 a month, and are used for transmitting stock quotations and other messages from one broker's office to another. Assistant District-Attorney Battle, who has charge of the matter, said the wires were not connected with the Stock Exchange. The Board of Electrical Control has been after the violators for some time, and has cut down a number of the wires

THE EDISON COMPANY WINS.—A suit was on trial last Wednesday in the Court of Common Pleas before Judge Bookstaver, brought by W. Preston Hix against the Edison Electric Light Company to recover $45,000 as commissions for the organization of the Edison Electric Light Company of Philadelphia. The basis of his action is founded upon an agreement which was entered into on Feb. 23 1886, with the Edison Company, by which Mr. Hix was to organize a company with a capital stock of $1,000,000, for which he was to receive 15 per cent. of the capital stock and 5 per cent. additional should any further increase be made in the capital stock. A company was organized in February, 1887, and, pursuant to agreement, Hix received $150,000 of the stock. Subsequently the stock was increased on several occasions until the increase amounted to $750,000. He now demands his commissions on this increase. The defence of the company was that in April, 1892, Hix signed a general release of all claims. The court decided in favor of the defendant.

RAILWAY TROUBLE IN JERSEY.—The directors of the Jersey City, Hoboken & Rutherford Railway have been trying for several months to obtain permission from the Hoboken Common Council to run their cars through Hoboken to the ferry. At present the road runs through Jersey City to the Hoboken line, where it stops. On Thursday there were happenings which seem to indicate that a scheme to outwit the authorities has been entered into by the Rutherford Company and the North Hudson County Railway Company. The latter company has a section of road from Paterson Avenue to Ferry Street, which was used by them before the elevated tracks were erected. The idea was for the Rutherford Company to run their cars over this line and thus get a clear road to the river. This piece of road has not been used in more than a year. On May 22 the Common Council passed a resolution ordering the North Hudson Company to tear up these tracks, but no notice was taken of it. At Thursday's meeting the matter was again brought up and a committee was appointed to wait on Manager W. H. Starr and inform him that the tracks must be taken up. They were told by him that the company would not do so, but, on the contrary, would at once commence running cars over the line. At 7 o'clock Friday morning Street Commission Baye, with a gang of men began tearing up the tracks. In a few minutes a car made its appearance, and shortly afterward several others came along. The drivers drove along over the stones where the tracks had been removed, but desisted after one or two trips. No effort was made to prevent the tearing up of the rails.

LONG ISLAND TRACTION AFFAIRS.—The Board of Directors of the Long Island Traction Company at a meeting last week elected Henry Seibert and Colonel T. S. Williams to fill the vacancies caused by the resignation of E. W. Bliss and the death of William Marshall. Colonel Williams was elected

secretary and treasurer in the place of W. A. H. Bogardus. President Daniel F. Lewis tendered his resignation, but action was deferred until next meeting. Clinton L. Rossiter, asst. supt. of the western division of the New York Central, has accepted the presidency of the Brooklyn Heights Railway, and will take Mr. Lewis's place on July 1. The plans for reorganizing the Long Island Traction Company, which is the lessee of the Brooklyn Heights road, contemplate the formation of a new company, which will assume the lease, assets, and liabilities of the old company; the formation of a new company with $20,000,000 common stock, to be exchanged for Long Island Traction stock on certain conditions; the issue of $6,000,000 of bonds to run ten years, and pay 6 per cent. interest; the levying of a 10 per cent. assessment on the stock of the Long Island Traction Company; the collateral notes to the amount of $1,800,000, which are mainly held by the Flower syndicate, to be taken up on Aug. 6, when the one year's option will expire; the guaranteeing by an underwriting syndicate to the new company the full payment of the assessment and full subscriptions to the stock. These plans will be approved in a few days by the directors and then submitted to the stockholders. It is reported that Chauncey M. Depew may be a director in their organized company.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
ROOM 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., June 22, 1895.

THE MASON REGULATOR COMPANY, of Boston, has removed its offices to 6 and 8 Oliver Street that city.

FORBES & GLIDDEN, electrical and chemical engineers, of Boston, have removed their offices to the new Worthington Building, 31 State Street. Their testing department will be continued at 620 Atlantic Avenue. We congratulate this young firm on the business recognition it is receiving and which it justly deserves.

MR. ARTHUR D. NEWTON, the popular and efficient secretary of the Eddy Electric Manufacturing Company, of Windsor, Conn., was united in marriage, June 12, to Miss Gertrude Hyde, of Hartford. We join with the many friends of Mr. Newton in wishing for him and his charming bride a life of uninterrupted happiness and prosperity.

THE FIFIELD TOOL COMPANY, of Lowell, Mass., which about a year ago succeeded to the old-established lathe manufacturing business of Mr. Geo. W. Fifield, of that city, carries in stock constantly all parts of lathes from 17 to 64 inch swing and is prepared to furnish at short notice, in fact immediate delivery, anything that may be desired. The lathe manufactures of this company are too well known to require any special comment, and the fact that they can be had quick and at prices comparing favorably with other manufacture should be an inducement worthy consideration.

THE IRESON RUBBER COMPANY, 97 High Street, Boston, is at present making a big reputation for its excellent manufacture of "Blue Blood Packing," and testimonials are constantly being received endorsing it in the strongest terms. This packing is used in all kinds of steam joints, ammonia joints, hydraulic pumps, and in fact any place where any kind of packing has ever been used or is necessary. The manufacturers are placing it on the market in very large quantities all over the United States, and are more than pleased to subject it to the most severe tests, which they solicit. In the hundreds of cases where this packing is being used the first complaint is yet to be received.

THE GRAHAM EQUIPMENT COMPANY, of Boston, reports business as very good. Mr. Graham's new equalized brake gear in connection with the excellent trucks manufactured by this company seems to be attracting universal and favorable attention. As is now pretty well known, this new brake gear enables the motorman to stop the car easier and quicker loaded than when empty. Formerly, as the truck was loaded the shoes went lower down on the wheels, decreasing their efficiency. Now they travel upward and occupy better position, and the motorman has a quick-acting positive brake. Only a little while ago the Graham Company made good shipments of trucks to Butte, Mont., Tampa, Fla., and Bangor, Me., and have made recent shipments to Atlanta, Ga., Jackson, Tenn., and Huntington, W. Va. The mail is bringing constant inquiries, and the energies of Mr. Graham and Mr. Gardner, of this company, are being very agreeably taxed at present.

ENGLISH NOTES.

(From Our Own Correspondent.)

LONDON, June 17, 1895.

TELEPHONE TRUNK WIRES.—The Lord Mayor of London held a conversation to-day with the corresponding functionaries of the two other capitals of the United Kingdom, namely, Edinburgh and Dublin, over the new telephone trunk wires which have been run up by the Postoffice in anticipation of the increased telephonic trunk business likely to accrue in consequence of the taking over of the telephone trunk system of this country by the Department. I may say that the total mileage of wire in the new Postoffice network amounts to over 10,000 and the weight of copper to nearly 3,000 tons. A quarter of this mileage is of 800-pound wire and about half of 600-pound wire, the balance running to 400 pounds per mile. The circuits are all on the twisted system and, in addition, where a large number of circuits are of the same pole, the twisted circuits are crossed at intervals.

BOARD OF TRADE REGULATIONS.—The revised Board of Trade regulations for insuring the safety of the public have, I am glad to say, been thoroughly discussed by a committee of the Institution of Electrical Engineers, by the Electrical Trade Section of the London Chamber of Commerce, and by a meeting of Borough Electrical Engineers. Central station managers, of course, propose extremely drastic modifications, their recommendations being in most cases of the nature of excisions. Although, no doubt, this course is largely justified by the generally academic and stringent nature of the regulations, such a way of dealing with a powerful government department is, of course, scarcely diplomatically correct, and not to be recommended if any modification whatever is wished for. I may say that there is every probability that the three bodies I have mentioned above will join in a common representation to the Board of Trade.

THE USES OF ACCUMULATORS.—An interesting paper on "The Uses of Accumulators" was recently read before the Northern Society of Electrical Engineers by Mr J. C. Howell. The paper consisted mainly of an *expose* of the saving effected at a certain American central station by the adoption of accumulators. Most of the speakers in the discussion were ready to admit the advantages of the judicious use of accumulators, but many of them doubted whether such a saving would be effected in this country where we apparently are in the habit of more carefully keeping our machines fully loaded. Several speakers went so far as to suggest a more or less extensive use of accumulators in connection with an alternating-current supply; the accumulators being used for exciting the alternators and for driving motor alternators during the hours of light load or heavy demand, the accumulators being charged by a rectified current from an alternator.

General News.

NEW INCORPORATIONS.

THE MILWAUKEE ELECTRIC MANUFACTURING COMPANY, Milwaukee, Wis., capital stock $8,000, has been formed by John E. McKivitt, Mathias Weisser and others.

THE NEODESHA TELEPHONE COMPANY, Topeka, Kan., has been incorporated by G. N. Bandy and W. I. Pierce to establish a telephone system. The capital stock is $5,000.

THE CHATHAM ELECTRIC LIGHT, HEAT & POWER COMPANY, Chatham, N. Y., capital stock $10,000, has been organized by J. F. Farrell, of Albany, H. M. Francis and J. O. Carr, of Schenectady.

THE JACOBSON-BLOSSER ELECTRIC COMPANY, Portland, Me., capital stock $200,000, has been incorporated with C. B. Jackson, of Boston, as president, and Alfred Prince, of Quincy, Mass., as treasurer.

THE ERIE REED PARK & LAKESIDE STREET RAILWAY COMPANY, of Erie, Pa., has been incorporated. Those interested are Chas. M. Reed, F. G. Curtze and Harry L. Moore. The capital stock is $50,000.

THE ERIE & EASTERN STREET RAILWAY COMPANY, Erie, Pa., capital stock $25,000, has been incorporated by Harry L. Moore, F. F. Curtze and C. M. Conrad, of Erie, Pa., to build an electric railway in that city.

THE NORTH TRUMBULL RAPID TRANSIT COMPANY, Warren, O., has been incorporated for the purpose of constructing a passenger and freight electric railway from Farmdale to Mesopotamia, a distance of 20 miles.

THE BUFFALO, GARDENVILLE & EBENEZER RAILWAY, Gardenville, N. Y., has been incorporated by Charles Schoepflin, Gardenville, Jacob Kissinger, C. H. Lamy and E. C. Shafer, of Buffalo, N. Y. The capital stock is reported as $40,000.

THE HALL ELECTRIC POWER & REDUCTION COMPANY, Des Moines, Ia., capital stock $500,000, has been formed by Thurston Gordon Hall, Robert H. Laird and Thurman Miles Hall, of Buffalo, N. Y., to manufacture and deal in electrical appliances.

THE UTICA & HERKIMER STREET RAILWAY COMPANY, Utica, N.Y., capital stock $30,000, has been formed to build and operate an electric railway three miles long. Those interested are D. S. Foster, G. E. Dennison, and B. A. Rogers, of Utica, N. Y.

THE WASHINGTON & TYLERDALE ELECTRIC LIGHT & POWER COMPANY, capital stock $1,000, has been incorporated at Washington, Pa., to supply light, heat and power to the public. J. P. Black, John W. Vester and John H. Murdoch are the promoters.

TELEGRAPH AND TELEPHONE.

CLARIDON, OHIO.—The Electric Telephone Company has been incorporated with a capital stock of $2,000.

DETROIT, MICH.—The Detroit Telephone Company has been incorporated with a capital stock of $10,000.

NORFOLK, VA.—The Southern Electric Service Company is petitioning for a franchise to construct underground conduits for a telephone system, etc.

OCEAN GROVE, N. J.—The Asbury Park Mutual Telephone Company, of which Washington White is president, has been granted the right to construct a line in Ocean Grove. Work will be begun at once.

CRANFORD, N. J.—The Township Committee of Cranford has promised a franchise to the New York & New Jersey Telephone Company as soon as the property owners' consents for the erection of poles have been obtained.

ELECTRIC LIGHT AND POWER.

WINDOM, MINN.—An electric light plant is to be established.

REYNOLDS, GA.—F. C. Goodwin is in the market for incandescent dynamos.

WILLMER, MINN.—Steps are being taken to establish an electric light plant.

SUMMERVILLE, S. C.—F. W. Wagner can supply information as to the proposed electric lighting plant.

COLUMBUS, ALA.—George L. Campbell can give information regarding the projected electric light plant.

DURAND, ILL.—M. Wilson, of Chicago, has been granted a 30-year franchise for a $10,000 electric light plant.

DILTON, MONT.—Matthew Orr has petitioned the Council for a franchise to construct an electric light plant.

WESTMINSTER, MD.—The Westminster Electric Light Company is putting in a 50-light dynamo and other machinery.

DAWSON, GA.—The Mayor will give information concerning the contemplated establishment of an electric light plant.

PORT TAMPA, FLA.—Work will begin at once on the erection of a large phosphate elevator to be operated by electricity.

WATERFORD, ONT.—Fitzgerald & Sauerman, P. O. Box 42, are in the market for an alternator of 500 or 750 lights capacity.

WORTHINGTON, MINN.—The city authorities have voted to issue $15,000 bonds for the construction of an electric light plant.

HALLETTSVILLE, TEX.—A new electric light plant is to be established. It will include a 900-light dynamo and an 85-hp engine.

FERGUSON, MO.—Downs & Ashbrook have about completed their electric light plant, for which they were recently granted a franchise.

OCEAN CITY, MD.—The Warfield Manufacturing Company, of Baltimore, has been awarded the contract for lighting the city by electricity.

MATTOON, ILL.—The city authorities are contemplating an increase in the electric lighting equipment in the immediate future. W. E. Tower is electrician.

LANSINGBURGH (P. O. TROY), N. Y.—A special election will be held July 1 to determine whether or not $13,000 shall be raised for lighting the streets by electricity.

GUTHRIE, O. T.—J. S. Brown, owner of the Guthrie Electric Light & Power Company, is in the market for additional equipment for 50 arc and 1,200 incandescent lights.

BROOK HAVEN, MISS.—F. F. Becker and others have organized a joint improvement company to establish an electric light plant, etc. The capital stock is given at $200,000.

TOLEDO, OHIO.—The ordinance has been passed granting permission to the Toledo Consolidated and the Toledo Electric companies the right to operate a system of underground wires in said city.

WAPAKONETA, O.—The village wishes sealed proposals for the furnishing and erection of one 1,000-volt alternator having a capacity of 1,500 16-cp lamps, with exciter, one switchboard, with all station instruments, 80 transformers of assorted sizes, 500 52-volt 16-cp lamps with 500 key sockets. Also the construction of two separate circuits, on electric poles now standing in the village, from the power house to centre of distribution, a distance of about 2,900 feet.

The Electric Railway.

LOUISVILLE, KY.—A movement is on foot to build an electric line from Louisville to Fairfield.

WATERLOO, IOWA.—An electric street car line to connect Waterloo with Cedar Falls will probably be built.

BUFFALO, N.Y.—A project is on foot for an electric railway to connect Buffalo and Olcott on Lake Erie, via Williamsville, Swampsville and Lockport.

WEST SUPERIOR, WIS.—The Superior Rapid Transit Company is about to make extensive improvements in its system. S. T. Norvell is general manager.

BUFFALO, N. Y.—Buffalo capitalists have a project on foot to build an electrical road to Gardenville, to be called the Buffalo & Gardenville Electric Railway.

DALLAS, TEXAS.—The Dallas Rapid Transit & Terminal Company has been organized by B. S. Watham, A. F. Hardie and others, to build an electric road in said city.

ERIE, PA.—It is reported that a company has been formed to build an electric street railway from Erie to North East. Frank L. McLaughlin, of North East, is interested.

MILFORD, VA.—It is reported that a company will be organized to build an electric road from Milford to Bowling Green, in Carolina County, a distance of about six miles.

HOBOKEN, N. J.—A petition for a franchise to the Jersey City, Rutherford & Hoboken Railway Company has been made to Council Chairman Timken of the City Council.

BELAIR, MD.—The narrow gauge tracks of the Baltimore & Lehigh Railway and the York Southern will shortly be converted into a standard gauge road and probably electrically equipped.

ST. LOUIS, MO.—E. J. Thurman, W. D. Waters, and J. B. Clayton, of Fentor, Mo., have been granted a charter to construct and operate a double track electric railway from St. Louis to Morse Mill, a distance of 35 miles

BLOOMFIELD, N. J.—The Bloomfield Township Committee has passed the ordinance granting a franchise to the Consolidated Traction Company for a trolley road on Bloomfield Avenue, between Newark and Bloomfield.

PITTSBURG, PA.—Mayor McKenna has signed the ordinance granting permission to the Central Traction Company to extend its line to the East End, by the way of Aliquippa and Melwood Streets and Centre and Begley Avenues.

LONG BRANCH, N. J.—Application has been made to the Township Committee of the township of Ocean, Monmouth County, by the Atlantic Coast Electric Railway Company for the construction and operation of a street railway.

MILFORD, MASS.—Money to build the proposed new street railway from South Framingham, through Holliston to Milford, has been pledged and the agreement to operate the road has been signed. Charles W. Shippee is interested.

WASHINGTON, D. C.—The Washington & Great Falls Electric Company has been granted permission to issue $500,000 in bonds to build its road. The line is about six and one half miles long and the trolley system will be used. The president is Stilson Hutchins.

CICERO, N. Y.—The Syracuse & Oneida Lake Electric Railway Company has made application for consent to construct, maintain and operate by animal power or electricity, a street surface railway, with necessary sidings, etc., along certain streets in this town.

STEVENS POINT, WIS.—The Stevens Point Electric Lighting Company has been given another year in which to begin the construction of an electric street railway under its franchise. By Sept. 10, 1896, it must have at least three miles of road completed, or forfeit $2,000.

BEVERLY, MASS.—W. B. Ferguson, Charles A. Richardson, N. E. Martin, A.B. Bruce, N. Sumner Myrick and Frank J. Perkins have petitioned to the Board of Aldermen for location of tracks with the necessary turnouts for the Gloucester, Essex & Beverly Street Railway Company.

BEAVER FALLS, PA.—A company is being organized to build an incline railway to Paterson Heights, a suburb of Beaver Falls. H. M. Meyers, John Reeves and other local capitalists are the principal movers in the enterprise. It will be 1,500 feet in length and operated by electricity.

ST. JOSEPH, MO.—The first step in the building of an electric line to St. George has been taken by the St Joseph Traction & Lighting Company. The company agrees to commence work within 90 days after the passage of the ordinance and have the road completed within six months thereafter.

WARREN, O.—The citizens of Mesopotamia, Green, Bloomfield, Gustavus and Kinsman have, under the name of the North Trumbull Rapid Transit Company, applied to the County Committee for a franchise to construct and operate an electric passenger and freight railway between Farmdale and Mesopotamia.

Personal Note.

MR A. E. KENNELLY has received from the Western University of Pennsylvania the degree of D. Sc., in recognition of his work in the theory of cable faults, for his researches in magnetism and alternating currents, and for his application of complex qualities in alternating-current work.

Miscellaneous Notes.

AN EDISON PATENT SUSTAINED.—Edison's patent granted Feb. 17, 1880, for "Method of Preparing Autographic Stencils for Printing," was sustained last week by Judge Acheson, sitting for the District of New Jersey, a final decree being entered in favor of the Edison patent awarding an injunction and accounting. The device of this patent has been put upon the market by Edison's exclusive licensee, and has become known as the Edison mimeograph.

THE NEW YORK ELECTRICAL SOCIETY, at its annual meeting, held on June 18, elected the following officers: President, John W. Lieb, Jr.; vice-presidents, Herbet Laws Webb, Edward Caldwell, Francis Forbes, Nelson W. Perry, Prof. L. H. Laudy and Prof. Morris Loeb; secretary, George F. Guy; treasurer, H. A. Sinclair. The secretary's report for the year shows a net increase in membership of 20. The number of members now on the books of the society is 370. Although last year the average attendance showed a marked improvement on the preceding year, during the season just concluded the society has had most gratifying evidence that the lectures have been even more thoroughly appreciated than ever. The range of subjects has been wide and in almost every instance the society has been fortunate in an able and exhaustive treatment of the theme selected. Some of the best lectures promised are still on the programme for next season, and will in all probability be delivered at an early date.

Trade and Industrial Notes.

A HEALTHY GROWTH of business during the past 12 months is reported by J. Jones & Son, 67 Cortlandt Street, New York, who have just finished their inventory and taken a balance from their books for the year.

SATISFACTORY SETTLEMENT has been made by Chas. E. Chapin with his creditors, and Mr. Chapin will resume business at once at 136 Liberty Street, New York, as manufacturers' agent, with an attractive line of specialties.

G. C. WOOLVERTON has sold out his interest in the Woolverton Electric Company, of Rahway, N. J., and has established a new business at 327 Washington Street, Buffalo, N. Y., where he is prepared to repair electrical apparatus of every description.

THE KNAPP ELECTRIC & NOVELTY COMPANY, 47 Warren Street, New York, reports an extremely good business in battery motors. Practical apparatus, judicious advertising and the reputation of the goods aid the dealers in selling large quantities of these outfits.

M. E. SANGER & CO. is the style of a new firm of model makers, instrument makers and general electrical manufacturers, with headquarters at 106 Liberty Street, New York. The new firm has ample facilities for doing experimental and special work in the best manner.

FULL TO OVERFLOWING is what the Dayton Fan & Motor Company, of Dayton, Ohio, reports as being the condition of its order book. The factory has hard work to keep up with orders, and the company is much gratified to have appreciation of its apparatus expressed in this manner.

DIEHL & CO., 385 Broadway, New York, report the receipt of many orders for their new ceiling fan, for which is claimed increased efficiency, giving a saving of about 25 per cent. of current usually required; improved mechanical construction, and a new oiling device insuring perfect cleanliness.

B. J. LAUNIERE, formerly secretary of the Grand Rapids Machinery & Electric Company, was recently engaged as traveling salesman by the Metropolitan Electric Company, 186-188 Fifth Avenue, Chicago. Mr. Launiere is well liked by the trade and is meeting with great success in the sale of electrical supplies.

EXTENSIVE NEW WORKS are now being constructed by the Sessions Foundry Company, Bristol, Conn., on a large tract of land near the railway. When the

new works are completed the company will have unsurpassed facilities for producing the best grade of castings in almost any quantity. It is expected that the works will be completed in the fall.

ANOTHER DESIRABLE SPECIALTY has been secured by the Electric Appliance Company, Chicago, due notice of which will be given in the near future. The specialty is a staple article for which there is a big demand, and its control and sale in the West by the Electric Appliance Company, who will carry a large Chicago stock, will give that concern quite an advantage.

TO HANG A MAN would not require nearly so much rope as was recently sold by the C. W. Hunt Company, 45 Broadway, New York, to the Niagara Falls Hydraulic Power & Manufacturing Company for a rope drive which necessitated 2,550 feet of rope. The Hunt Company furnished its special "Stevedore" brand, which is made particularly for transmission purposes.

A WINDMILL LIGHTING PLANT has recently been installed at the residence of Mr. W. E. C. Eustis, Milton, Mass., containing a storage battery of 1,000 ampere-hours capacity furnished by The Bradbury-Stone Electric Storage Company, of Lowell, Mass. The battery is of the very latest type in lead lined wooden tanks. The plant is the second largest installation of this character in America.

A RIVAL OF THE GRAVITY BATTERY.—The Gordon primary battery, now being placed on the market as a substitute for the gravity battery, is strongly endorsed in a recent letter from Mr. W. M. Kinch, the assistant superintendent of signals of the N. Y. C. & H. R. railway, as the result of a severe test extending over five months of railway signal work. He states that the battery has three strong features in particular—simplicity of form, low internal resistance and standing up under the severest short circuits. The battery is manufactured by the Gordon-Burnham Battery Company, 82 West Broadway, New York.

THREE HUNDRED CONTRACTS and more have been closed by The Electrical Maintenance Company, 50 Broadway, New York, for the maintenance of electric lighting and power plants, electric elevators, etc., in office buildings, factories and central stations; and its business is rapidly assuming large proportions, notwithstanding the company has only been organized about five months. W. J. MacConnell, long and favorably known to the electrical trade, is general manager of the company.

THE NEW CONGRESSIONAL LIBRARY at Washington, D. C., will have a very complete plant when finished. Crook, Horner & Co., of Baltimore, representatives of the Ball Engine Company, Erie, Pa., are installing in the building three 175-hp Ball engines, direct-connected to Mather dynamos. The Ball Engine Company has also sold the city of Galveston, Texas, a "Ball" automatic engine for direct-connection to a Western Electric dynamo, and has secured the contract for the engines to be installed in the new Security Building, St. Louis.

AN ORNATE CATALOGUE is being distributed by the Electric Launch Company, Morris Heights, New York, in which are described launches of every type; yacht tenders, fishing and hunting launches, cruising launches, etc. The equipment is described in detail. An interesting feature is the controlling device, the hand wheel of which is located just in front of the steering wheel, the spindles of the two being concentrically disposed. The catalogue possesses only one disadvantage: the reader is seized with a strong desire to immediately forsake work and take an outing in one of these beautiful little craft.

MOST OF THE LEADING MANUFACTURERS in this country use Carpenter rheostats exclusively, and quite a number of the prominent foreign manufacturers, such as Crompton & Co., of London; Ludwig Loewe & Co., of Berlin; Brown, Boveri & Co., of Switzerland; Union Electricitats Gesellschaft, of Berlin, and many others less well known over here, are ordering these rheostats regularly and in increasing quantities. The Carpenter Enamel Rheostat Company, of Hoboken, N. J., reports a demand for these goods which has kept the factory running overtime for several months past.

THAT TIRED FEELING is an unknown quantity with H. B. Coho & Co., 203 Broadway, New York, who are always on the move for business. Among numerous other contracts this firm has closed the following during the past six weeks: 80-kw multipolar generator for Broadway Central Hotel, New York City; 15-kw multipolar generator for Hotel Vandyke New York City; 80-kw generator for Schnoering Apartments, West Ninety-fourth Street, New York; 45-hp generator for Henry R. Worthington, Elizabethport, N. J.; 25-hp and 5 hp motors for Alexander-Chamberlain Electric Company; 80-kw multipolar generator for Paterson, N. J.

MUNICIPAL LIGHTING PLANTS.—It has frequently been stated that city lighting plants are few in number, of ancient installation, and fast disappearing from sight, but the number of sales made to municipalities by the Standard Electric Company, of Chicago, would indicate the reverse. During the past few months this company has installed nearly a dozen municipal lighting plants, among them one for the city of Springfield, Ill., having a capacity of 700 arc lamps; and one each for Logansport, Ind.; Paducah, Ky.; Fulton, Mo.; Jamestown, N. Y.; Harrisonville, Mo.; Independence, Ia.; Willoughby, Ohio; Kearney, N. J., and Chesaning, Mich.

GEORGE A. McKINLOCK, president of the Central Electric Company, Chicago, is a visitor in New York this week. Mr. McKinlock reports an exceptionally brisk business for the summer months and is particularly well satisfied with the large number of Lundell Fan Motors sold. Mr. McKinlock can properly claim to be one of the pioneers in the electrical industry, having been connected with telephone interests for a considerable time previous to the organization of the Central Electrical Company, which started business in Chicago early in 1887. He has successfully guided his business from a small beginning through all the different stages to be met with in business growth, and has to-day the distinction of being at the head of one of the largest electrical supply houses in the world.

FRANK DE RONDE, well and favorably known as general sales-agent for the Standard Paint Company, has, in connection with his brother, A. De Ronde, taken the selling agency for the United States and Canada of the "Ship" cored carbons, manufactured by Schiff, Jordan & Co., Vienna, Austria, who are reported to be the largest manufacturers in their line on the Continent. These carbons are said to be of exceptionally high grade, insuring, where they are used, a steady, brilliant light, with minimum consumption of current. The manufacturers expect to ship all large orders direct from the factory, but will carry a large stock in this country, thus enabling their agents to fill orders immediately when so desired. The New York office will be at 254 Front Street. Messrs. Schiff, Jordan & Co. are to be congratulated upon securing the services of the De Ronde brothers, who can be relied upon to push the sale of their carbons by all honorable means. Messrs. De Ronde intend establishing agencies at once in all sections of the country, so that central-station managers and others can be supplied promptly.

A CHICAGO ACQUISITION.—The Brown Hoisting & Conveying Machine Company and the Elwell-Parker Electric Company of America, main offices and works at Cleveland, Ohio, have jointly opened a general western office at 1528 Marquette Building, Chicago. Mr. F. G. Tallman, manager of the Pittsburg offices of these companies, and late manager at Pittsburg for the crane department of the Yale & Towne Manufacturing Company, will also have charge of the Chicago office and will be assisted by Mr. Frank B. Ward, late resident engineer of the Pittsburg Testing Laboratory, Limited, and for several years head of the firm of Frank Ward & Co., inspecting and consulting engineers. The Brown Hoisting & Conveying Machine Company, in connection with its hoisting and conveying machinery and crane business, has recently purchased the entire crane business heretofore owned and controlled by the Yale & Towne Manufacturing Company. The Elwell-Parker Electric Company of America, which is the American branch of the celebrated English firm of the same name, is making a specialty of heavy electric machinery and large installations.

Business Notices.

ELECTRIC LEAGUE.—Meets every Thursday evening, 100 West 24th Street, New York. Electrical engineers and electricians cordially invited.

BATTERY CUT-OUT, CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren Street, Syracuse, N. Y.

Illustrated Record of Electrical Patents.

UNITED STATES PATENTS ISSUED JUNE 18, 1895.

[In charge of Wm. A. Rosenbaum, 177 Times Building, New York.]

541,078. ELECTRIC CAR BRAKE; G. B. Damon, Lowell, Mass. App. filed April 30, 1894. The combination of an independent motor adapted to operate an air pump, a tank for storing the same, and means whereby when the pressure in the said tank shall fall to the minimum for an electric circuit to actuate the motor and so compress sufficient air to apply the brakes.

541,077. TELEPHONE SYSTEM; W. W. Dean, St. Louis, Mo. App. filed Feb. 21, 1895. The combination of a local transmitter circuit comprising two parallel branches, two induction coils each having a primary in one of the branches of the transmitter circuit, and the secondary in the telephone line in series, a microphone and a battery adapted to direct current through the said branches in parallel.

541,081. STORAGE BATTERY AND METHOD OF MAKING SAME; N. H. Edgerton, West Whiteland, Pa. App. filed Feb. 27, 1894. In a storage battery, a series of cells with intervening conducting partitions and surrounding non-conducting frames molded thereon, the said cells filled with an electrolytic fluid, and the terminal partitions having conductors leading therefrom, and an envelope of plastic non-conducting material in an enclosing case adapted to retain the gaseous elements evolved in the charging and discharging of electric currents.

541,098. CROSSING FOR TROLLEY WIRES; J. Kroger, Pleasantville, N. J. App. filed Nov. 3, 1894. A cross-over for trolley having a central depression and a portion of the grooves cut away, locks having the cross-heads so set as to form part of the wall of the grooves at crosses.

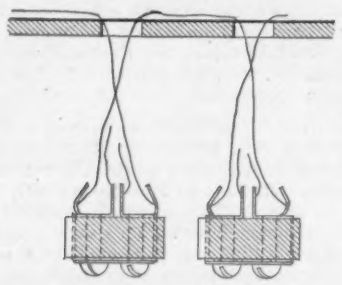
541,136. RHEOSTAT OR OTHER CIRCUIT CONTROLLER; C. Willms, Baltimore, Md. App. filed Nov. 26, 1894. The combination with a rheostat having a body of resistance material forming a path for the current and divided into sections by a series of collecting sectors consisting of wires extending across the resistance material and secured at their ends, and tension pins for the wires intermediate of their ends.

541,148. CURRENT STRENGTH INDICATOR; F. G. Burgess, Boston, Mass. App. filed March 25, 1895. The combination of an electromagnet and armature mechanically actuated for applying to said armature a steadily increasing force in opposition to the attraction of the magnet, an indicating device, a stopping or locking device operating to arrest and prevent the further movement of the indicating device, whereby an approximate indication is obtained of the resistance offered by the said magnet to the movement of the armature.

541,149. TRANSMITTER; J. Burry, New York, N. Y. App. filed Oct 23, 1893. The combination of a rotary shaft with a switch thereon, brushes bearing on the switch, opposing magnets, with the armature between them a source of electrical energy, and electric conductors.

541,152. DISTRIBUTING FRAME FOR TELEPHONE CIRCUIT CONDUCTORS; F. B. Cook, Chicago, Ill. App. filed Jan. 9, 1895. An appliance for

transferring electric conductors consisting of a plate upon the front side of which parallel insulating blocks are secured at a suitable distance therefrom, the said blocks having upon their upper and lower edges metal conductor terminals from which conductors extend through the plate to the rear side and there divide, all the conductors coming from the lower terminals extending in one direction, and all from the upper extending in another direction.



No. 541,152.—Telephone Circuit Distributing Frame.

541,165. ELECTRIC RAILWAY; R. M. Hunter, Philadelphia, Pa. App. filed Jan. 12, 1887. The combination of a car body with its supporting wheels and axles, with an electric motor connected to one axle through a frame work independent of the motor proper, having bearings arranged at a distance apart, and supported at the other end by a single support.

541,179. ELECTRIC ARC LAMP; C. A. Pfluger, Chicago, Ill. App. filed July 2, 1894. The combination of two carbons at an angle with each other, tubes containing the said carbons, a solenoid connected to the said tubes so as to be supported thereby, and a pivotal connection between the core of the said solenoid and each of the tubes, so that the tubes are moved by the movement of the core.

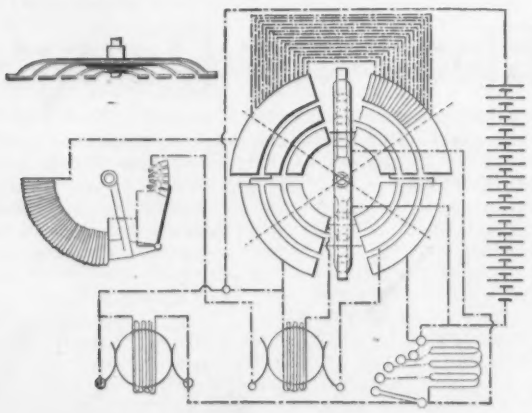
541,200. ELECTRIC ELEVATOR; R. Eickmeyer, Yonkers, N. Y. App. filed Oct. 1, 1890. In an electrically operated elevator mechanism, the combination of a shunt-wound electric motor, an armature circuit supplied from generators and accumulators, and a resistance which is automatically adjustable to counter electromotive force as it is developed in the motor.

541,225. REPEATER; M. G. Crane, Newton, Mass. App. filed Aug. 4, 1894. The combination with two or more circuits of a controller for each circuit adapted to respond to changes therein, a main motor adapted to operate in response to a movement of any of said controllers, and a secondary motor adapted to restore the said controllers to their normal positions.

541,227. ELECTRIC SWITCH; C. P. Elieson, London, England. App. filed July 16, 1894. The combination of a receptacle composed of non-conducting material, supporting pivots therefor, engaging said receptacle adjacent to one end thereof extending within the same, and forming circuit terminals and a movable conducting body within the said receptacle.

541,233. SYSTEM OF ELECTRICAL DISTRIBUTION; C. K. Huguet, New Orleans, La. App. filed Jan. 30, 1895. The method of maintaining a constant current on a constant potential circuit, consisting in establishing an inductive balance between the constant potential circuit and a separate constant current circuit and altering or distributing this balance in proportion to the change of impedance which takes place on the constant potential circuit.

541,248. PUSH BUTTON; F. W. Manger, Brooklyn, N. Y. App. filed Oct. 1, 1894. The combination of a base adapted to receive contact devices, a shell inclosing the said contact devices and having a screw-threaded flange at its outer end, a button passing through the shell and adapted to engage the contact devices, a cap or ring adapted to screw on said screw-threaded flange and having an internal flange, and a disc of soft material over the said button, the disc being held at its edges between the end of the flange of the shell and the internal flange on the cap or ring.



No. 541,200—Electric Elevator.

541,259. RAIL BOND; W. E. Baker and H. M. Brinckerhoff, Chicago, Ill. App. filed March 11, 1895. The combination of a rail bond secured to a rail and a flange of a girder, the girder end of the bond being presented at right angles to the plane of the flange.

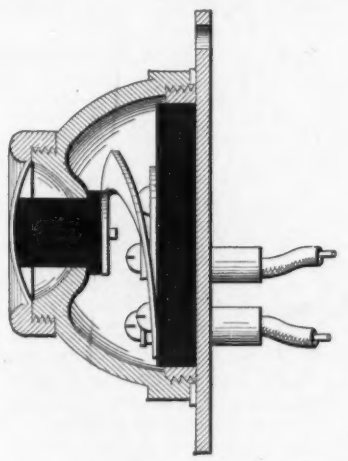
541,286. APPARATUS FOR STEERING VESSELS; W. R. Moore and W. Megarvey, Cleveland, Ohio. App. filed Feb 23, 1895. The combination of a tow-line having a lever connected thereto and adapted to be swung on a horizontal plane, a rotatable post to support the lever and to be turned thereby, two horizontally swinging arms and connections between the arms and the rotatable post whereby when the lever is swung the arms will be moved in opposite directions on a horizontal plane.

541,287. ELECTRIC STOP MOTION FOR ENGINES; Eugene C. Myrick and George C. Doeg, of Providence, R. I. App. filed May 23, 1893. The combination, with a governor and valve-detaching mechanism, of mechanism connecting the governor and the valve-detaching mechanism, the said connecting mechanism being constructed in two detachable parts, one of the parts being provided with an independently movable engaging device for engaging the other part and carrying an electromagnet and its armature for operating the engaging device to disconnect the two parts of the connecting mechanism.

541,290. ARC LIGHTING; S. W. Rushmore, Brooklyn, N. Y. App. filed March 20, 1895. The combination of two arc lamps connected in series, each lamp having suitable carbons and feeding mechanism, a coil of each of the lamps in shunt to its own arc only, and a second coil at each lamp in shunt to the arc of the other lamp only.

541,332. INSULATOR; J. M. Patterson, Springtown, Texas. App. filed April 10, 1895. An insulator formed of two sections of insulating material adapted to fit together and each provided on its inner sides with a longitudinal recess, and blocks notched on their inner faces and adapted to be inserted in the said recesses, with their notches coinciding to form a passage for the wire.

541,338. UNDERGROUND CLOSED CONDUIT SYSTEM FOR ELECTRIC RAILWAYS; A. J. Smith, Milwaukee, Wis. App. filed June 6, 1894. The combination of a conduit having one or more trolley chambers, an independent conducting chamber having a conductor therein, insulated metallic shafts communicating at intervals from the conducting chamber to the trolley chamber, adapted to be rocked into contact with the conducting wire, and an actuating arm having a reciprocating trolley track connected thereto, but supported independently from the top of the trolley chamber.



No. 541,243.—Push Button.

541,341. ELECTRIC ALARM SIGNAL AND INDICATOR FOR TROLLEY RAILWAYS; J. A. Buisson, New Orleans, La. App. filed April 2, 1895. The combination with a main trolley wire or feeder of a short auxiliary wire extending parallel therewith, means for rigidly and mechanically connecting the two wires, the ends of the auxiliary wire being turned up to form inclined shoes capable of readily receiving a trolley wheel, and a wire connected to one upturned end thereof, the said connection being out of the plane in which the main portion of the auxiliary wire is located.

541,350. PORTABLE GALVANIC BATTERY CELL; F. A. Glasgow, St. Louis, Mo. App. filed Sept. 18, 1894. The combination of a battery cell provided with a removable zinc-holding screw plug, the zinc element being inserted in the said screw plug, and a removable tube adapted to inclose the zinc.

541,357. COMPOUND-WOUND ALTERNATING GENERATOR; J. D. Hilliard, Jr., Bluefield, W. Va. App. filed June 21, 1894. A method of regulating the current of an alternating generator which consists in shunting a part of the main current of the generator through a rectifying or commutating device and through the series winding of the field of the generator, arranging a variable inductive resistance in the shunt circuit, and providing an automatic cut-out actuated by the increase of current in the resistance to short circuit the said resistance.

541,367. ELECTRIC TRUSS; B. R. Lathrop, Weedsport, N.Y. App. filed Aug. 27, 1894. A truss having a pad containing a battery, and a screw passing through the bearing face of the pad, and making contact with the battery pole, and provided with a pole plate combined with a support connected at one end of the pad, the back pad mounted on a support and also provided with poles which are connected with the support.

541,380. ARMATURE FOR ELECTRIC MOTORS AND GENERATORS; J. F. McLaughlin, Philadelphia, Pa. App. filed Dec. 5, 1891. An armature consisting of a cylindrical iron body provided with troughs opening into the periphery, armature coils removably seated in the said troughs, and an iron wire wrapping constituting a magnetic shield continuous both longitudinally and peripherally over the cylinder.

541,389. ELECTRIC TRAIN SIGNAL; E. J. Devine, Port Arthur, Canada. App. filed Dec. 11, 1894. The combination of a series of wires and a circuit closer provided with a frame and a movable shield, said wires extending into or mounted on the said frame and shield, one of them having an uninsulated portion, another of said wires also having an uninsulated portion extending across the plane of said former uninsulated portion.

THE ELECTRICAL WORLD

AN ILLUSTRATED WEEKLY REVIEW OF CURRENT PROGRESS IN ELECTRICITY AND ITS PRACTICAL APPLICATIONS

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Entered at the New York Post Office as Mail Matter of the Second Class.

Vol. XXV. No. 26. NEW YORK, JUNE 29, 1895. $3 a Year in the U. S., Canada or Mexico. $6 to Foreign Countries in the Postal Union.

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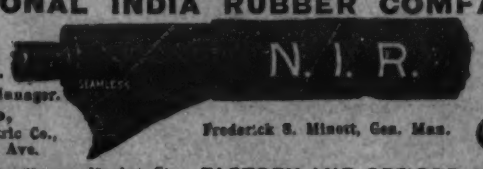

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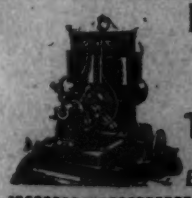

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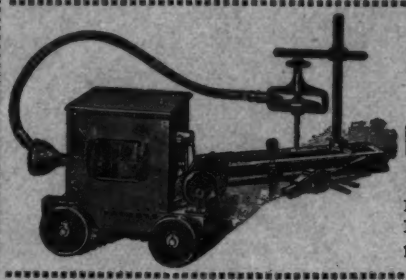

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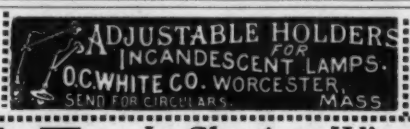

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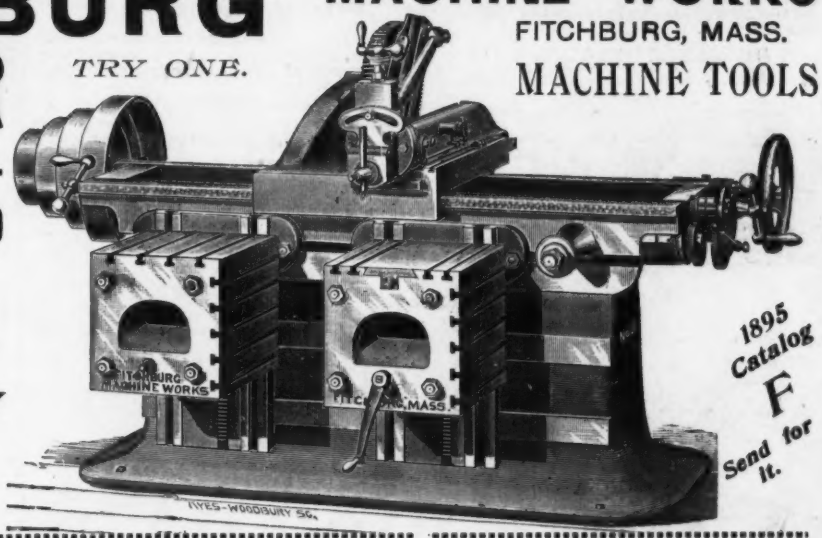

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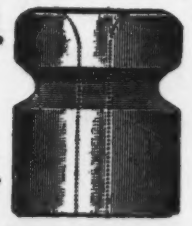

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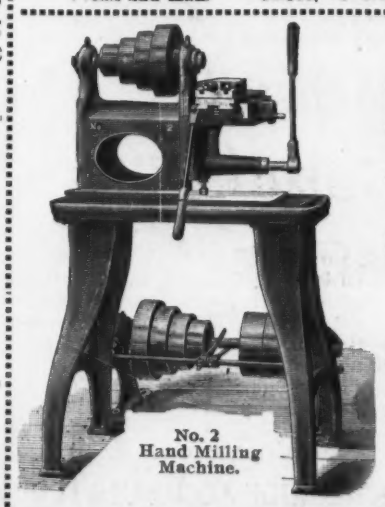

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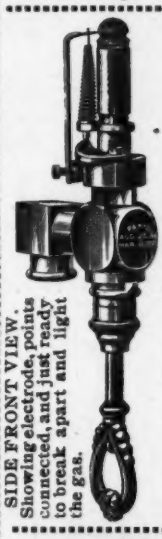
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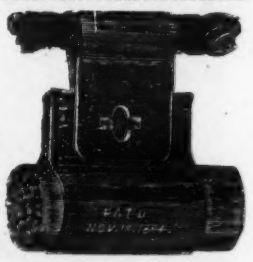
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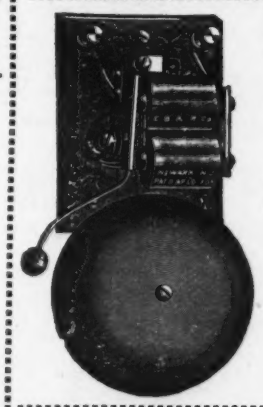

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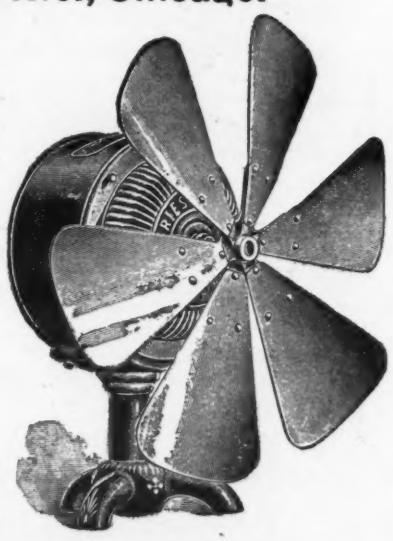

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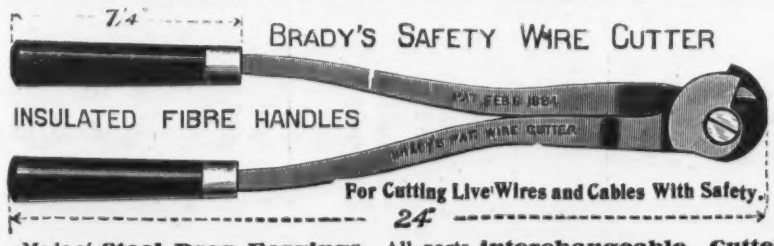

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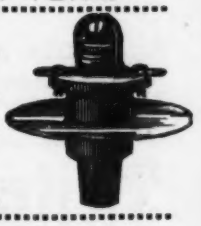

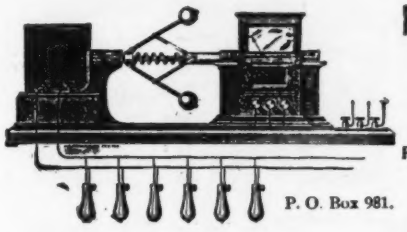

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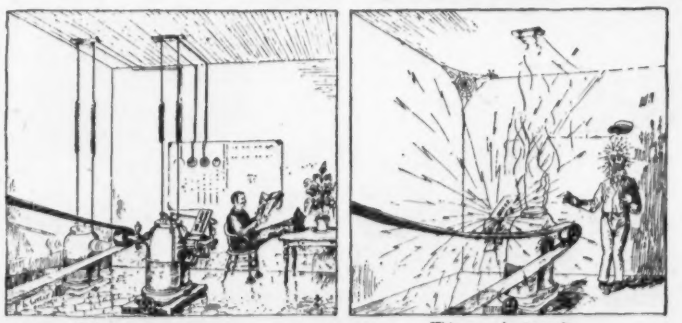

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934-935 Monadnock Building (Telephone—Harrison 636) CHICAGO, Illinois

This Motor

is pre-eminently adapted for special work where self-protection from dust, moisture and injury by external causes is necessary.

It is the ideal motor for direct driving.

Efficiency
as high as the highest.

No Heating.

Absolutely Sparkless,
even under wide variations of load.

10 H. P. STANDARD MOTOR.
[In writing mention THE ELECTRICAL WORLD.]

THE
STOREY,

Ironclad, Completely Closed in, Dust Proof, ...

DIRECT CURRENT

Motor and Dynamo,

Manufactured by

The Storey Motor and Tool Co.,
MAIN OFFICE,
Cor. York St. & Sedgeley Ave., Philadelphia.
New York Office, 120 Liberty St.

Switchboard Instruments.

Volt and Ammeters for direct and alternating circuits. Points of merit—Guaranteed accurate to 1 per cent.; Large open scales, dead beat, gravity control and, last but not least, **Cheap.** Special sale of direct current instruments of the Magnetic Vane type.

For a Portable Voltmeter use our "Acme."

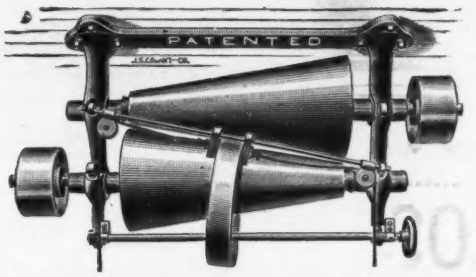
Have you seen our reduced prices on Standard Resistances, Condensers and high grade Galvanometers? If not, write for circular No. 655.

Repairing and Standardizing of all kinds of Electrical Apparatus a Specialty.

QUEEN & CO., Inc.,
J. G. GRAY, Assignee.

New York Office, 116 Fulton St.
1010 Chestnut St., PHILADELPHIA, PA.

The Evans Friction Cones.



Thousands of sets of variable Speed Cone Pulleys in operation driving all kinds of Machinery.

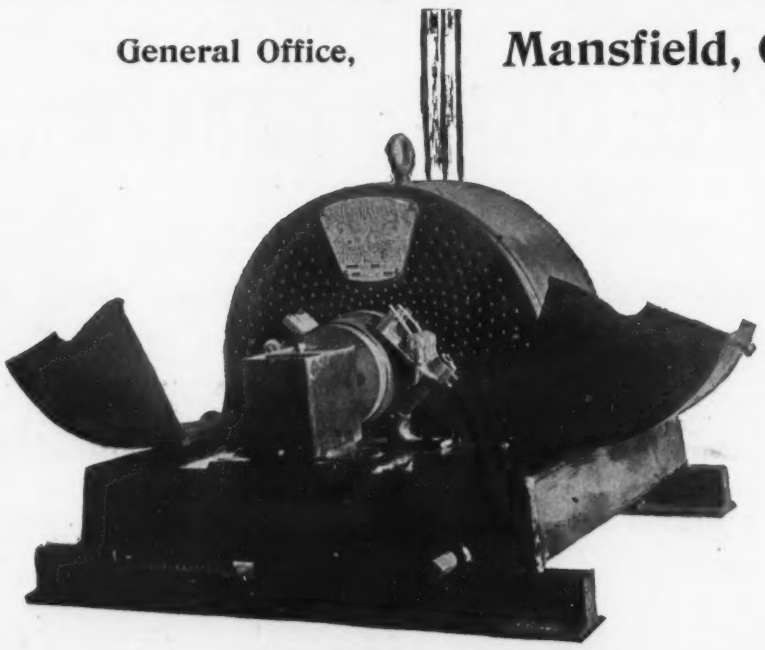
For information send for catalogue. Address

EVANS FRICTION CONE CO.,
85 Water Street, BOSTON, MASS.

The Card Electric Company,

General Office, **Mansfield, Ohio.**

ron Clad Controller for Traveling Cranes and Hoists.



IRON CLAD MOTOR.

Iron Clad.

Railways, Mines, Power Stations, and Isolated Plants Equipped.

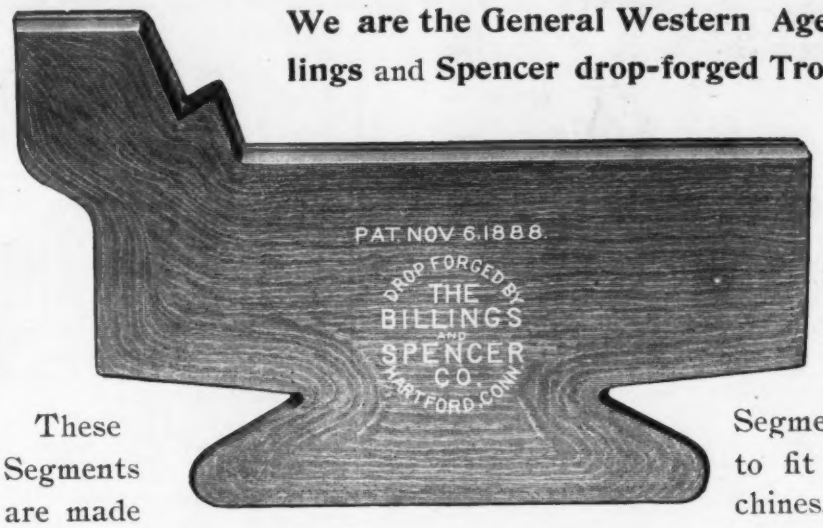
Our Machinery is built to STAY SOLD.

Anybody can start our machines. Just the thing for EXPORTERS. Requires positively no experience.

Agecies: J. HOLT GATES, 1139, 1140, 1141 Monadnock Bldg., Chicago, Ill. H. B. COHO & CO., 203 Broadway, New York City. FORD & SMITH, 18 Wade Bldg., Cleveland, Ohio. BISSELL & DODGE, 518 Summit St., Toledo, Ohio. NIAGARA ENGINEERING CO., Buffalo, N. Y. CHAS. F. BURNS & CO., 20 So. St. Paul St., Rochester, N. Y. FRED. W. C. BAILEY, 30 E. Gay St., Columbus, Ohio. THE ELECTRIC SUPPLY CO. OF SYRACUSE, Syracuse, N. Y. B. F. ALLISON, Springfield. Ohio. THE OLD DOMINION ELECTRICAL CONSTRUCTION CO., Richmond, Va.

Agents wanted in unoccupied territory.

Electric Railway Supplies.



We are the General Western Agents for the Billings and Spencer drop-forged Trolley Equipments and Commutator Segments

These Segments are made from pure Lake copper, finished and tempered to give a compact, uniform wearing surface.

We can supply Segments **from stock** to fit all standard machines.

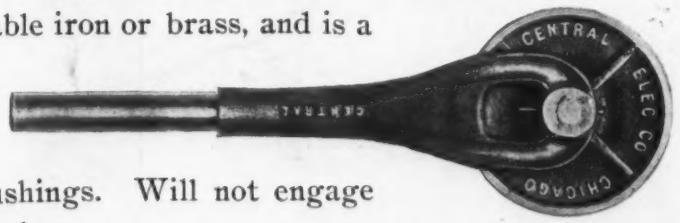
Overhead Material.

Drop-forged Straight-line Hangers, Single and Double Curve Pull-offs, Bracket-arm Insulators, Barn and Bridge Hangers, Feed Wire Hangers, Eureka Trolley Wire Clamps.

The tough, durable filament of the **Pharos Incandescent Lamp** makes it a particularly satisfactory one for Street Railway Use. They successfully bear the fluctuations of current, and the jolting and jarring of travel.

Central Trolley Harp and Wheel.

This harp is made of malleable iron or brass, and is a very strong, well designed head. The wheels are of bronze furnished with the best grade of graphite bushings. Will not engage with and break down span wires.



Central Electric Company,

173-175 Adams Street,

CHICAGO.

ST. LOUIS, Southern Electrical Supply Co.

KANSAS CITY, Gate City Electric Co.

As cool as a cucumber — A Lundell Fan.

A Chance to Smile.

Refined Tastes.

A rather pointed story is told of Senator Blackburn, of Kentucky, and the late Senator Beck, which we give without varnish.

Upon one occasion it was necessary to test some Old Bourbon Whiskey before shipping the Simon Pure to a fastidious customer. The anxious dealer bethought him of these two great men, who were universally admitted to be connoisseurs in the article, and begged their indulgence in the matter of tasting the liquor. Blackburn swallowed a sip, smacked his lips, looked a little bit critical, tried it again, and then said: "It is fair—very fair—but," again smacking his lips, "it seems to me I taste iron in it." The dealer looked discouraged.

Beck went through the same process of tasting and trying, at last exclaiming: "That's good—very good—but I think I detect a taste of leather."

The dealer's face fell. But feeling sure he had a superior article he investigated. After diligent search he found a *carpet-tack with a leather cap* in the bottom of the cask.

According to reports there will be less than half a crop of apples this year, but the out-put of pure cider vinegar will not be materially reduced unless the weevil, or other destructive forces injure the sawdust or corn cob crop.

A colored meeting was lately held in a certain place, at which the attendance was large and the converts numerous. The stove-pipe happening to fall, the minister asked one of the bredderin to put it in position again. Brother Johnson essayed to do it, but being rather slow, the old minister said: "Pick it up, brudder, pick it up; de Lord won't let it burn you."

Brother Johnson, with faith in the assurance, seized the hot pipe, and of course had his hands blistered. He dropped it with the inappropriate remark, "*De debbil he won't.*"

It was just a little heavy for him.

Side Track Gossip.

"I expect I'll be fired, remarked the locomotive, "unless I tender my resignation."

"O, pshaw!" exclaimed the baggage car, "the company 'steams you too highly for that."

"Well, I hope so," answered the engine, "but you see I've been running out of nights, and having an occasional toot, and I'm afraid they'll get onto my track and turn the tables on me."

Voltaire, when he began the study of English and found that "ague" was pronounced two syllables and "Plague" as one, said that he wished that half the English had the one disease and the other half the other.

Considerable annoyance has been experienced by Electric Railways in replacing armature coils of the new types of motors, as it has been impossible, without the aid of expensive machinery, to shape these coils properly or get the exact amount of wire needed, consequently it has been necessary for them to send direct to the factory for them at the expense of long shipments and delays.

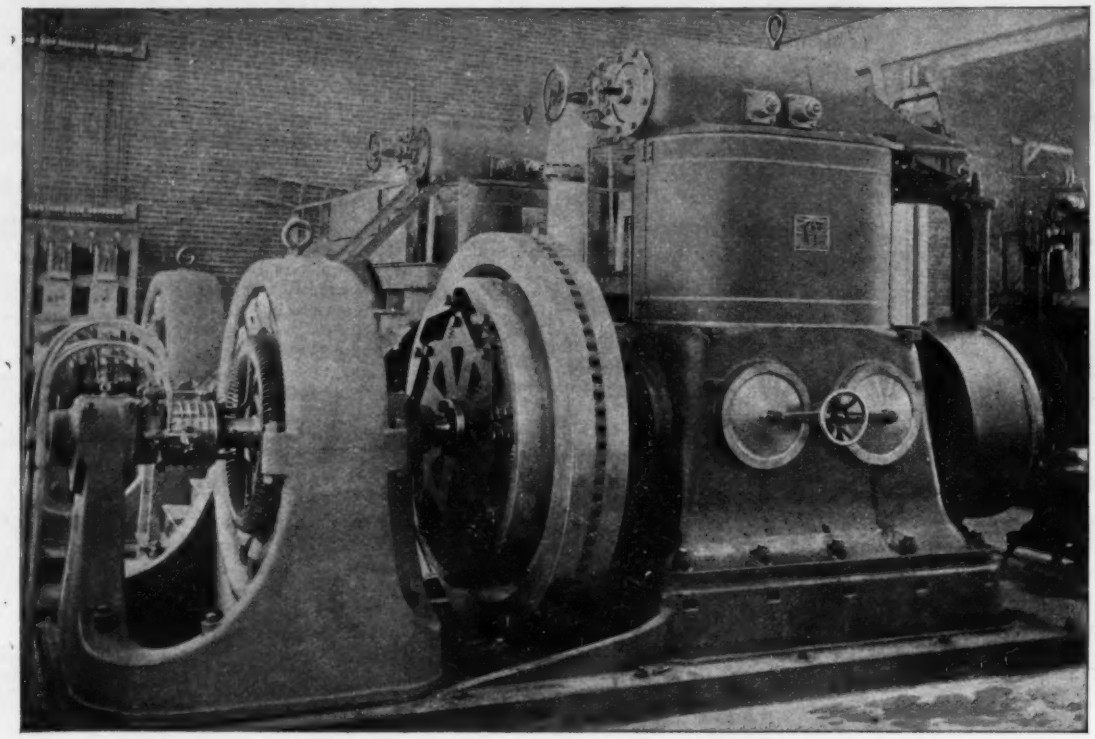
The Central Electric Company has succeeded in making these coils and guarantees them to be absolutely perfect in form and required amount of copper. They are, at present, able to supply Armature coils for G. E. 800 and Westinghouse No. 3 Motors. They will shortly be prepared to supply coils for all new types of Motors.

An Ounce of Preventive.

"An ounce of prevention is worth a pound of cure, ain't it?" said Meandering Mike.

"Of course it is," replied Plodding Pete.

"Well, dat's de reason I don't accept no job from nobody. Ef I wus workin' I might be tempted ter go on a strike an' den see de trouble I'd be in."—Washington Star.



500 HORSE-POWER POLYPHASE GENERATORS IN POWER HOUSE OF THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, AT EAST PITTSBURG, PA.

WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY,

SOLE OWNERS OF THE

TESLA POLYPHASE SYSTEM.

The Ideal System for the distribution of power and light in factories and mills.
Motors, arc lights and incandescent lights supplied from the same circuits.
The system adopted by the Cataract Construction Company for their great plant at Niagara.
Adapted for transmission of power over long distances, also for local distribution of power.
Brushes and moving contacts may be dispensed with rendering the system peculiarly useful in mining operations.
All machinery in our new works at East Pittsburg driven by Tesla Polyphase Motors, supplied from a central power plant. RESULTS: High Efficiency, Convenience, Economy of Installation and Operation and Flexibility. Inspection invited.

Two suits are now pending against the Thomson-Houston Company under the Tesla Patents. Upon motion of the Westinghouse Company in the Circuit Court at New Haven recently the Thomson-Houston Co. were limited to October 7th to take their testimony in defense. The suits will therefore be ready for argument in the near future.

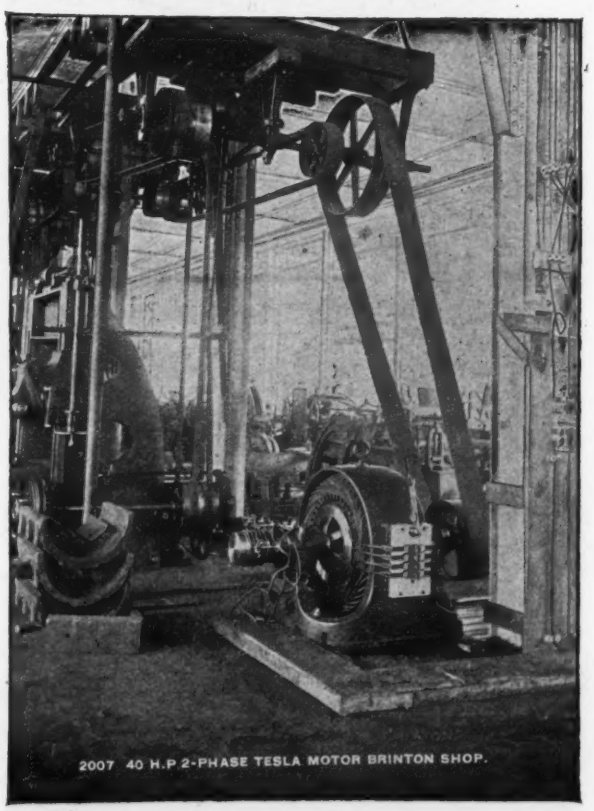
The novelty of Mr. Tesla's invention was recognized by **Prof. Elihu Thomson,** who said in discussing the Tesla inventions before the American Institute of Electrical Engineers in 1888:—

"I have certainly been very much interested in the description given by Mr. Tesla "of his **new and admirable** little motor. I have, as probably you may be aware, worked "in somewhat similar directions and towards the attainment of similar ends. The trials "which I have made have been by the use of a **single** alternating current circuit, not a "**double** alternating circuit."

Westinghouse Electric and Manufacturing Company,

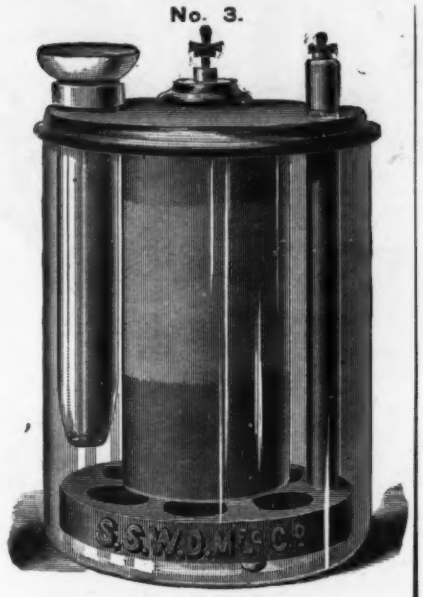
PITTSBURG, PA.

BRANCH OFFICES IN ALL THE LEADING CITIES.



FORTY HORSE-POWER TESLA POLYPHASE MOTOR OPERATING MACHINERY IN SHOPS AT EAST PITTSBURG.

No. 3.



Jar. 6 in. x 8 in.

E. M. F. 1.9 to 2 Volts.

CURRENT ON SHORT CIRCUIT 1 TO 2 AMPERES.

Price reduced to **$1.50** per cell.

...THE...

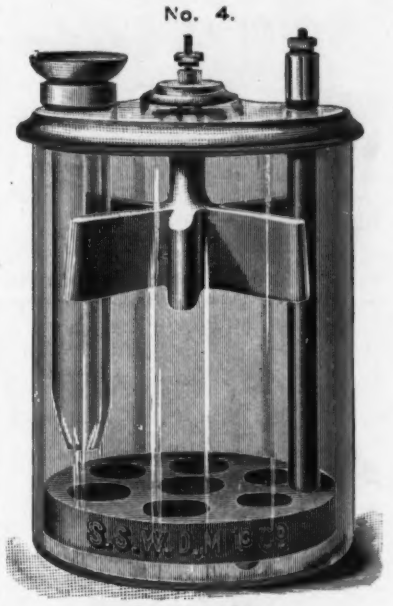
Partz Acid Gravity BATTERY

FOR ALL OPEN CIRCUIT WORK.

The highest voltage,
strongest and longest
lasting Battery in the world.

AWARDED MEDAL AND DIPLOMA AT COLUMBIAN WORLD'S FAIR, AFTER COMPETITIVE TESTS.

No. 4.



Jar. 6 in. x 8 in.

E. M. F. 1.9 to 2 Volts.

CURRENT ON SHORT CIRCUIT 3 TO 5 AMPERES.

Price reduced to **$1.50** per cell.

For **HEAVY ELECTRIC BELL WORK, ANNUNCIATORS, OPEN CIRCUIT ELECTRIC SIGNALS, ELECTRIC CLOCKS, WATCHMAN'S CLOCKS, LONG DISTANCE AND CONTINUOUSLY USED TELEPHONES, Etc., Etc.**

120 Cells in Constant use in the Philadelphia Electrical Bureau on Fire Alarm Gongs for Five Years.

EXTRACT FROM ANNUAL REPORT OF PHILADELPHIA ELECTRICAL BUREAU.

DEPARTMENT OF PUBLIC SAFETY, ELECTRICAL BUREAU.
FEBRUARY, 1893.

* * * * * * * * *

These batteries (the Partz Nos. 3 and 4) have been in use on our alarm circuits for four years, never having failed in that time. The zincs first put in are still doing duty, and have the appearance of holding out for four years longer, They require very little attention. When the voltage and amperes fall, a tablespoonful of the sulpho-chromic salts dropped into the gravity-tube brings them up to their normal condition.

... A Statement and a Claim ...

In the general offices of the Pennsylvania Railroad Company, South Fourth Street, below Walnut, Philadelphia, six cells of the Partz Acid Gravity Battery, with Porous Cup, have been used for ringing the bells of the entire building since 1888. There are about 500 of the bells, which are manipulated by about 1,000 push-buttons. These cells have the liquid replaced and are given a thorough cleaning about once a year, on an average. When the current shows any sign of weakening a small quantity of Partz Sulpho-Chromic Salt is dropped in each cell, on an average about three or four times each year. Further than this they have received no attention. The old zincs were replaced twice during the five years the cells have been in continuous service. Is it too much to claim that there is not another battery in existence that could do this?

PARTZ SULPHO-CHROMIC SALT

FOR USE IN ....
Partz Acid Gravity Batteries

... AND FOR ...

MAKING ELECTROPOION FLUID—ECONOMY, SAFETY EFFICIENCY.

Sulpho-Chromic Salt, when dissolved in water, makes a standard electropoion fluid without the necessity of handling liquid acids, having practically the same amount of stored energy as an equal quantity of fluid made in the ordinary ways, giving with a zinc-carbon element an E. M. F. of 1.9 to 2 volts, and an ampere-hour capacity of about the same.

We specially call the attention of battery-users to this substance as affording the best, cleanest and most convenient method of making electropoion fluid for medical batteries, Grenet cells, Bunsen batteries, for lecture tables, experimental work, etc., and motor batteries.

Sulpho-Chromic Salt is put up in air-tight jars with screw lid, each jar containing two pounds. As the salt is hygroscopic, it must be guarded against moisture. **Price per jar, 2 lbs., 75 cents.**

The attention of Architects, Contractors, Builders, Dealers in Electrical Supplies, Telephone Companies, etc., is called to this Battery.

SEND FOR CATALOGUE GIVING FULL PARTICULARS.

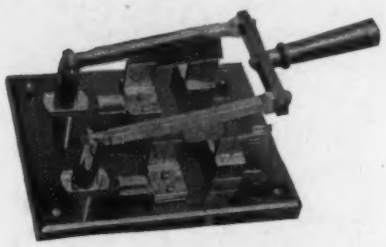
MANY OF THE LARGE HOTELS THROUGHOUT THE COUNTRY ARE NOW REPLACING UNSATISFACTORY BATTERIES WITH THE PARTZ ACID GRAVITY BATTERY

MANUFACTURED AND FOR SALE BY

The S. S. White Dental Mfg. Co.,

CHESTNUT ST., cor. TWELFTH ST.,
PHILADELPHIA, PA.

BRANCHES: NEW YORK: Lincoln Building, 1 and 3 Union Square, W. " Sixth Ave., S. W. Cor. Forty-second St. BOSTON: 110 and 112 Boylston St. CHICAGO: 151 and 153 Wabash Ave. BROOKLYN: 446 and 448 Fulton St. ATLANTA; 66 South Broad St.



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Paying exorbitant prices for KNIFE SWITCHES.
We make any capacity.
Write for prices and mention Elec. World. Special prices for next 30 days.

H. B. SKILES,
Belmont and Westminster Ave.,
Factory, 3015 Chestnut St., PHILADELPHIA, PA

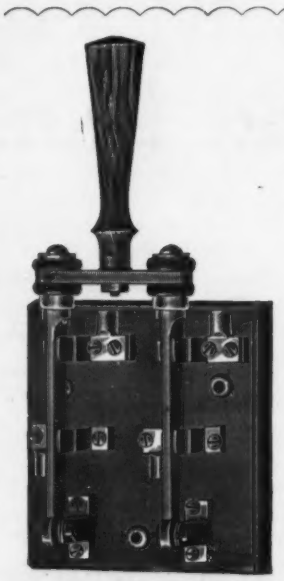
IF you want the Best and Cheapest **SWITCH**

on the market send and get our catalogue and Prices.

Our Motor Switch Can't Be Beat

LINTON & SOUTHWICK,
Office and Factory:
56, 58, 60 Hermon Street.
Worcester, Mass.

W.S. HILL ELECTRIC CO.



Manufacturers of

Switches and Switchboards

For all Purposes and Uses.

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NEW YORK
J. A. Machado, 203 Broadway

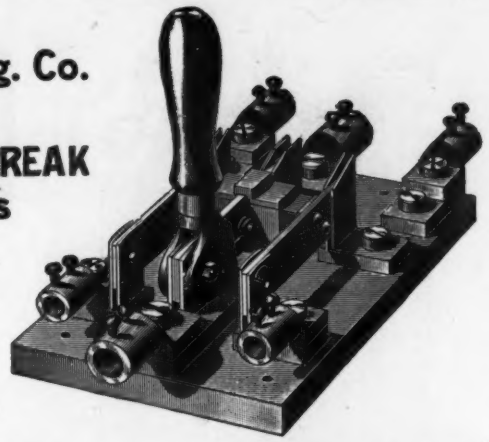
CHICAGO
Central Electric Co.

The Brooklyn Electric Mfg. Co.

Manufacturers of

QUICK-BREAK Switches

Slate Switchboards
Panel Boards
Cut-Out Boards and
Electrical Specialties



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69 DUANE STREET, NEW YORK.

AN IMPROVED

Attachment Plug.

(Pat. May 21, '95.)

IS FLUSH WITH THE WALL OR FLOOR AND FURNISHED WITH OR WITHOUT LID.

HALF SIZE.

WM. T. PRINGLE & CO.,
1026 and 1028 FILBERT ST.,
PHILADELPHIA, PA.

MANUFACTURERS

Switches, Switchboards, Etc.

HART FLUSH SWITCHES

5 and 10 Ampere Single Pole.
10 Ampere Double Pole.
10 Ampere Three-Way.

Can be furnished with Lock and Key if desired.

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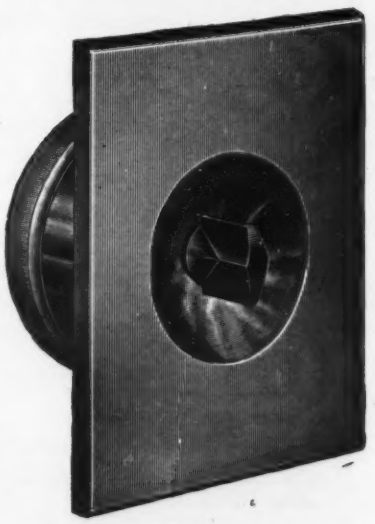
THE
HART & HEGEMAN MFG. CO.
HARTFORD, CONN.

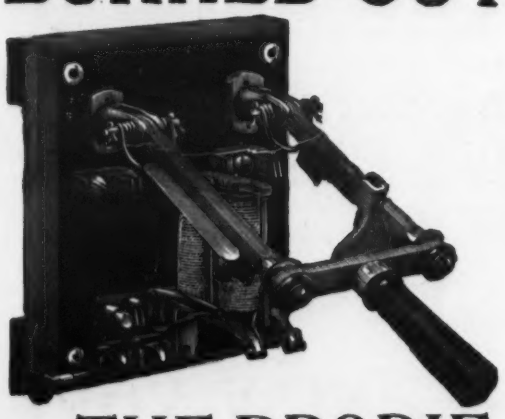


BURNED-OUT ARMATURES ARE AVOIDED

...IN MOTORS PROVIDED WITH...

THE

Brodie Automatic Motor-Switch.

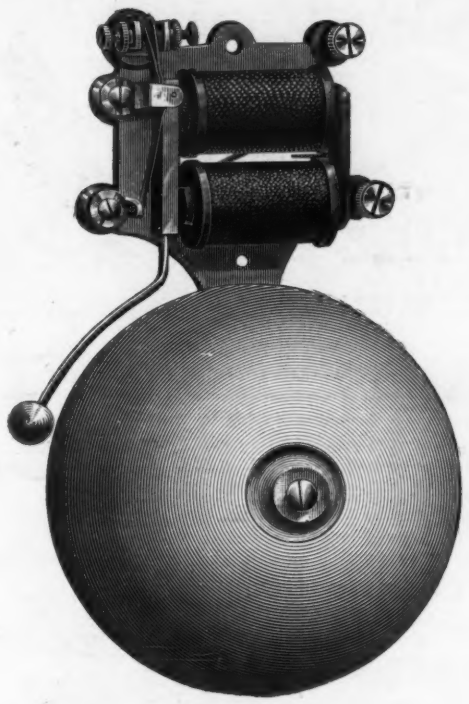


This device combines a double pole switch, a limit switch and an automatic cut-off, and employs carbon arcing-contacts to take the spark upon breaking the circuit. For circulars and prices address

THE BRODIE ELECTRIC COMPANY, MANCHESTER, N. H.

AGENTS WANTED.

14 H. E. & C. BAXTER, BROOKLYN, N. Y.



2607

H. E. & C. BAXTER, BROOKLYN, N. Y. 15

ELECTRIC BELLS.

"BAXTER" SKELETON BELL—PATENTED.

In placing this bell on the market, our aim has been to meet popular prices, at the same time produce a bell equal to the best. Our several improvements as applied to the construction has accomplished our object. We have found that those with experience and judgment readily appreciate its good points, and in consequence our sales have steadily increased.

The parts are highly finished nickel, on a well japanned frame. The adjusting, contact, pivot aud binding posts have our patent fastening, centralizing and securely holding them. The bell has both battery and stroke adjustment provided with set nuts. By placing the double adjustment at the back of the armature, we do away with the adjustable contact screw, which is a decided improvement, as the make and break of the contact points are the same with either a long or short stroke, allowing the armature to feel the full force of the magnets throughout its movement.

Catalogue No. 2607.

5 inch,	Wrought	Gong,	Nickel	Plate.	....	$1.90
6 "	"	"	"	"	....	2.10
5 "	Cast	"	"	"	....	2.30
6 "	"	"	"	"	....	2.70
7 "	"	"	"	"	....	3.70
8 "	"	"	"	"	....	4.30

Manufacturers of the well-known . . .

"STANDARD"

Iron-Box and Wood-Box . . . .

Bells

The No. **7707**

IRON-BOX BELLS,

Style **D,**

SKELETON BELLS,

and a variety of other Electrical Appliances, such as Annunciators, Burglar Alarms, Push Buttons, Floor Pushes, Window and Door B. A. Springs, etc.

H. E. & C. BAXTER,

Canton, Bedford and Division Sts., BROOKLYN, N. Y.

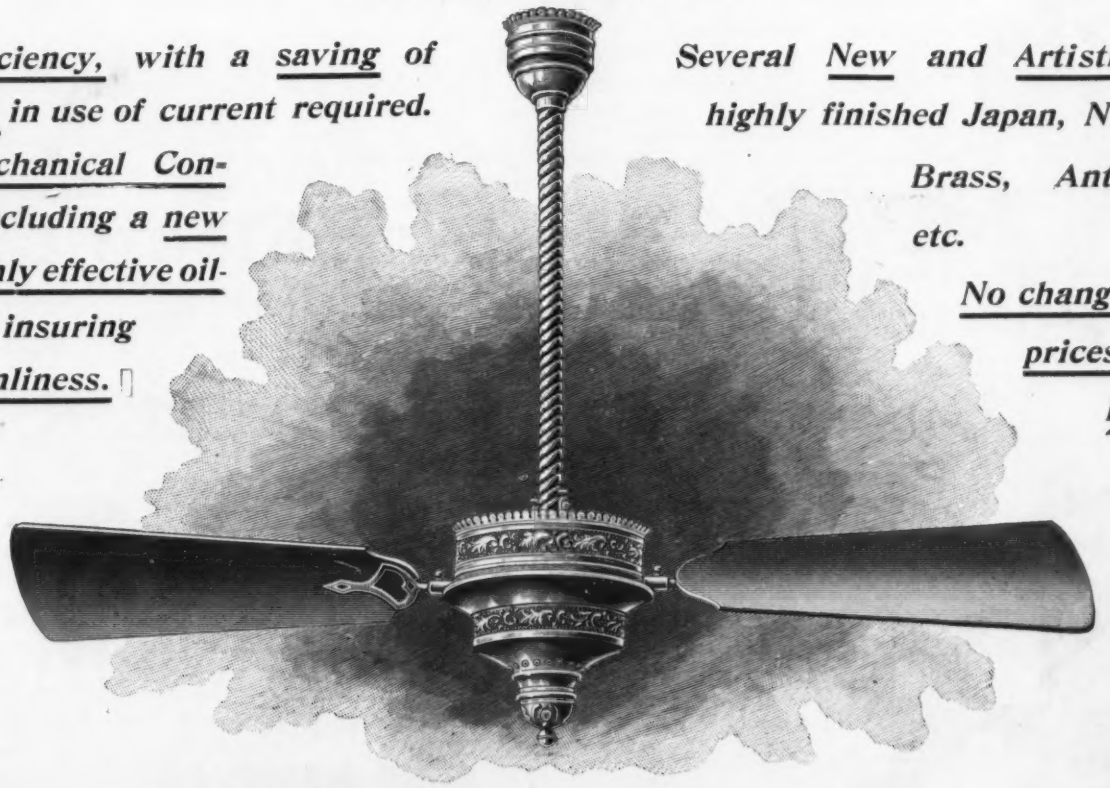
To introduce our "**BAXTER**" Bell quickly to the trade, we will express, prepaid, a sample (one only) to any city in the United States, on line of general express companies, on receipt of price.

The New DIEHL Electric Ceiling Fan.

JUST PERFECTED.

Increased efficiency, with a saving of 25 per cent. in use of current required.

Improved Mechanical Construction, including a new and thoroughly effective oiling device, insuring perfect cleanliness.

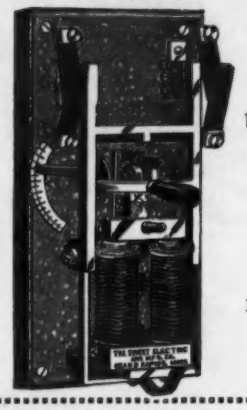


Several New and Artistic designs, in highly finished Japan, Nickle, Polished Brass, Antique Copper, etc.

No change from former prices. Prompt delivery.

DIEHL & COMPANY, 385 Broadway, NEW YORK.

Automatic Circuit Breaker Co.,



Successors to SWEET ELECTRIC & MFG. CO.,

We can save you money; as our Circuit Breaker or Limit Switches have been tested, pronounced a success in every detail, and proved superior in every respect to all others. Adapted to any switchboard, and used on direct or alternating current systems. Write us now, prices are just ripe.

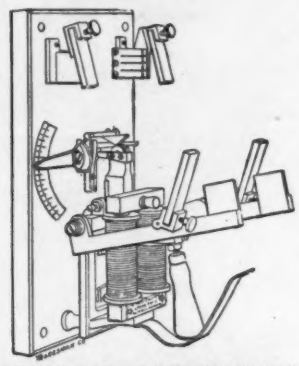
AUTOMATIC CIRCUIT BREAKER CO.,

NEWAYGO, MICH.

Foreign Agency

J. B. STONE & CO.,

135 FINSBURY PAVEMENT, LONDON, ENGLAND.



Flies are Coming

Fans are Going

to drive them away and

KEEP YOU COOL

Beautiful in Design

ELECTRIC

CEILING and COLUMN FANS

ORDER EARLY : : : :

NEW MOTOR FOR 1895

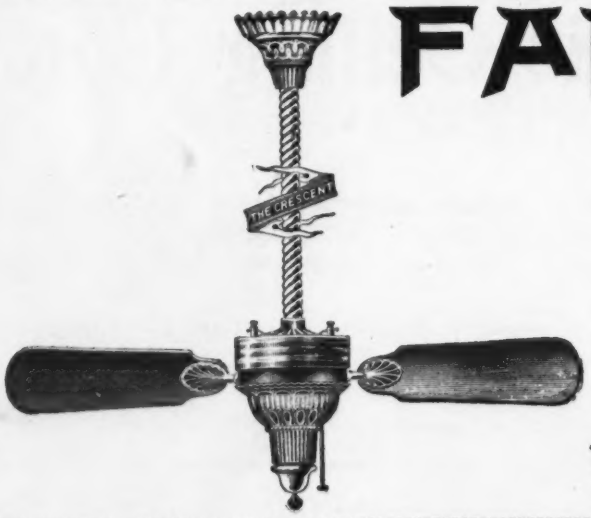
Guaranteed Electrically and Mechanically

For particulars address

BACKUS MFG. CO.

Newark, N. J.

FAN MOTORS



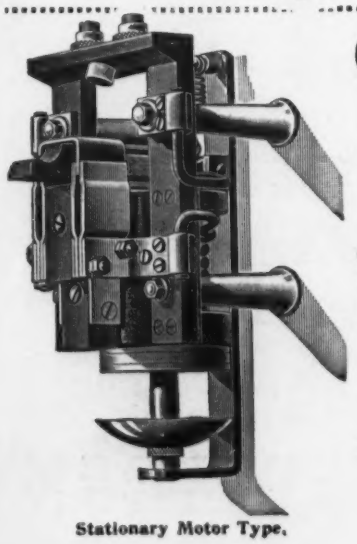
For DIRECT and ALTERNATING CURRENTS.

SPECIAL CIRCULAR No. 209 NOW READY.

Western Electric Co.

Thames & Greenwich Sts. NEW YORK.

227-275 South Clinton St. CHICAGO.



Stationary Motor Type.

C-S Automatic Magnetic Circuit Breaker

The Cutter Electrical Mfg. Co.

1112 Sansom St.,

PHILADELPHIA.

New York, Chas. D. Shain, 136 Liberty St.
Boston, Chas. E. Bibber, 620 Atlantic Ave.
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THE "RIKER"

Combines all that is desired in a fan—and the prices are . . .

...RIGHT...

AGENTS WANTED.

RIKER

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DAYTON ELECTRIC *Ceiling Fans*

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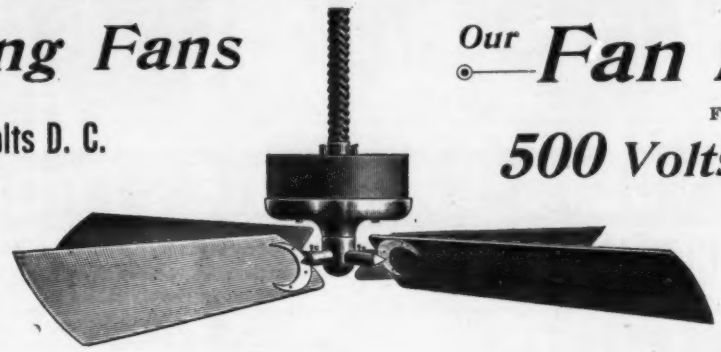

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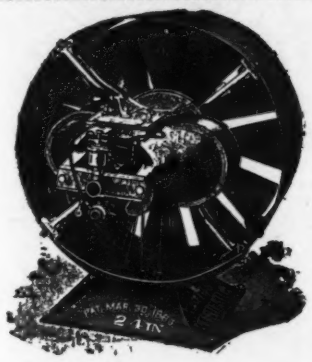

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It should be, What is the proper means for Ventilating and Cooling **OFFICES, STORES, DYNAMO** and **ENGINE ROOMS, LAUNDRIES, HOTEL KITCHENS, FOUNDRIES,** and all kinds of **Public Buildings?**

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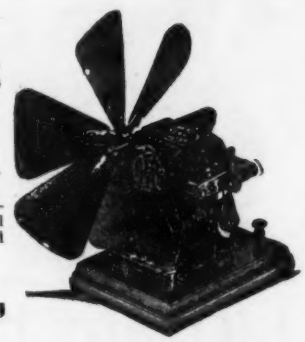

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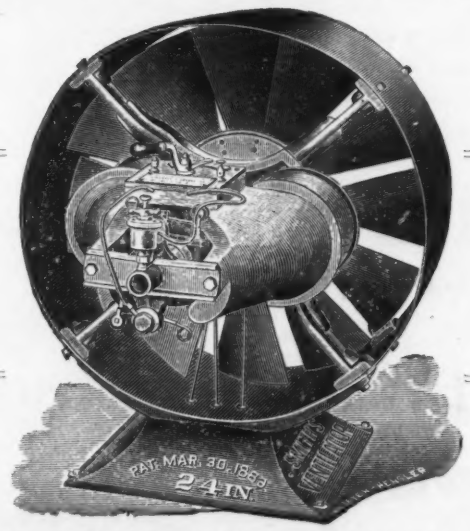

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220 "
500 "

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What you Want is FRESH AIR—not the same air churned over and over again, as is the case with toy fan motors of the 10 and 12 inch variety.

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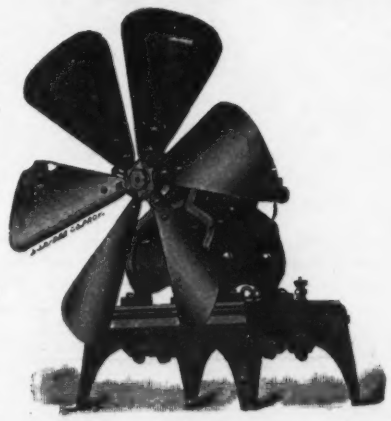

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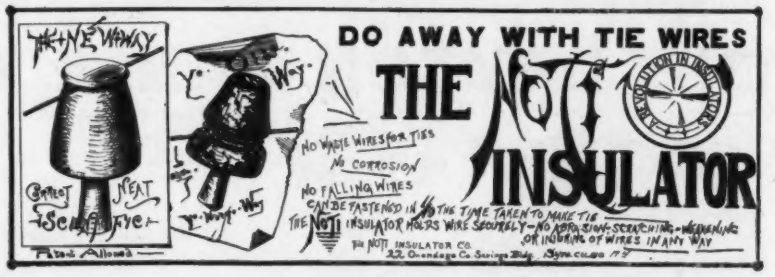
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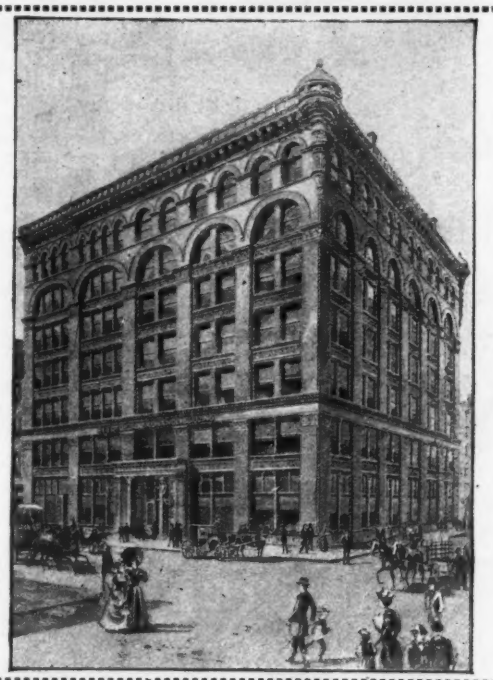

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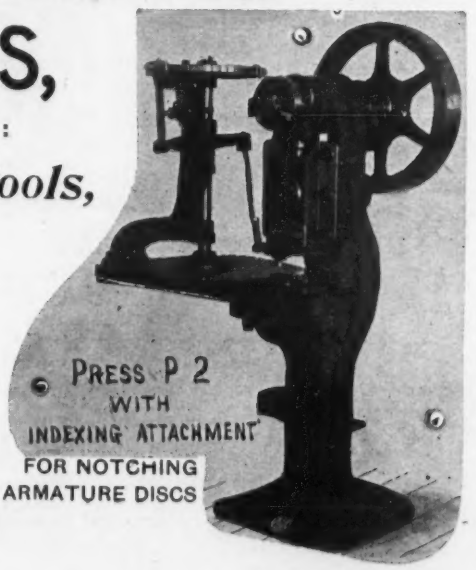

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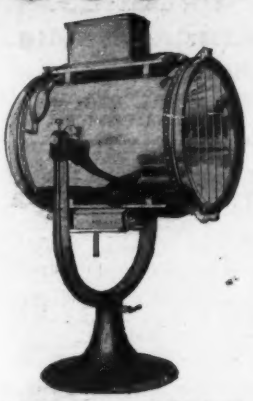

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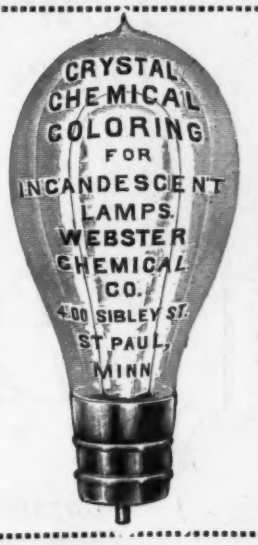

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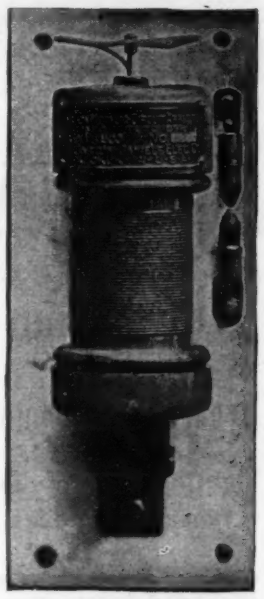

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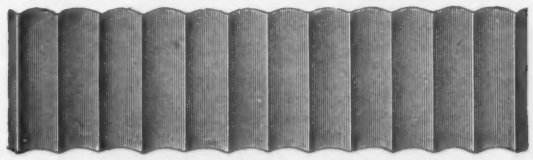

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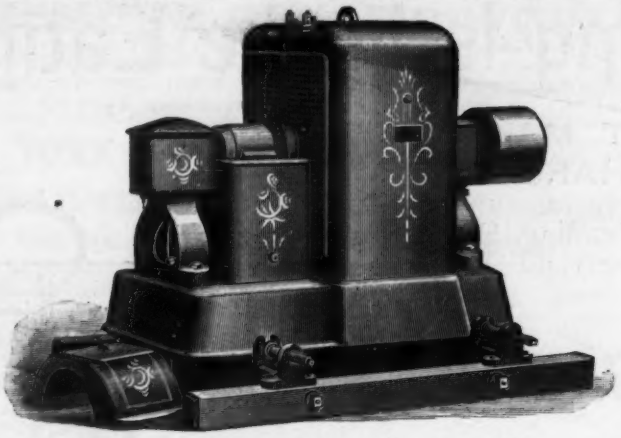

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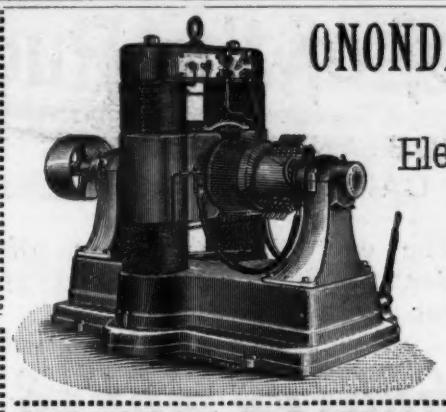

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Electrical Efficiency and Mechanical Construction Guaranteed.

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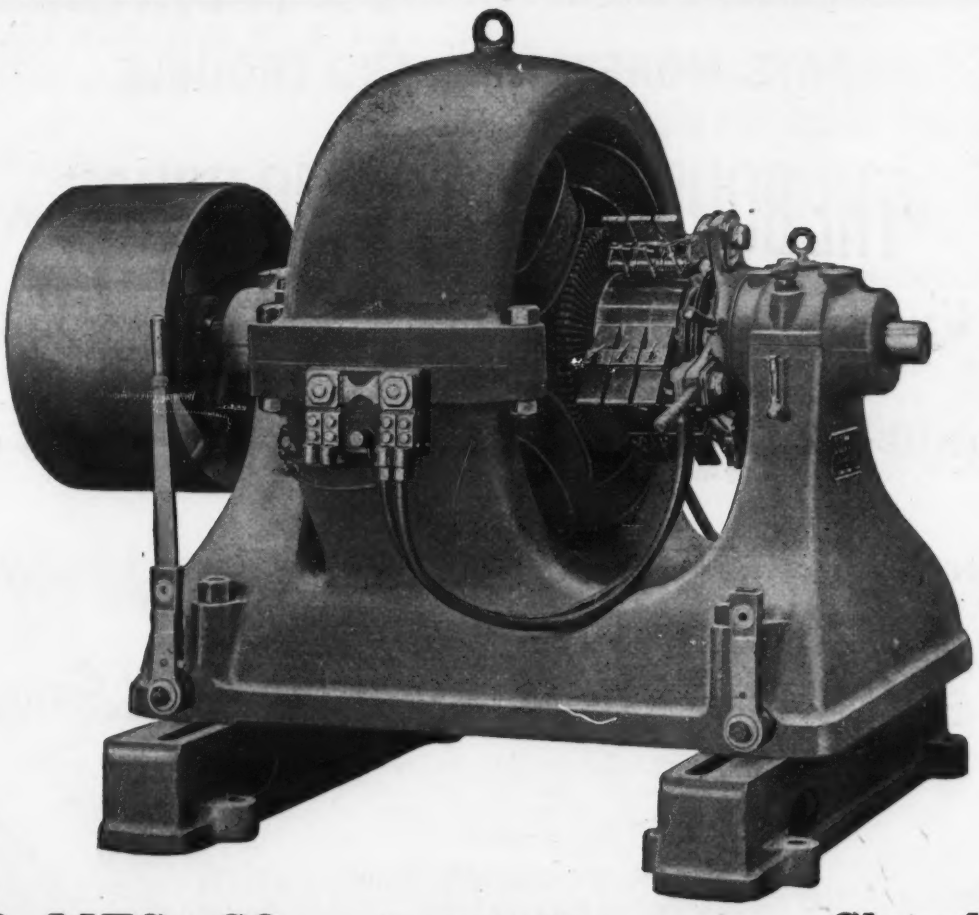

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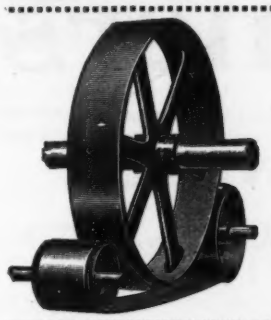

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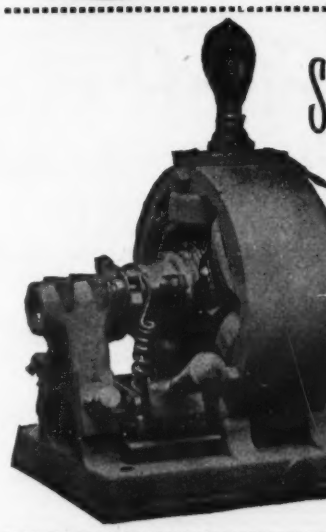

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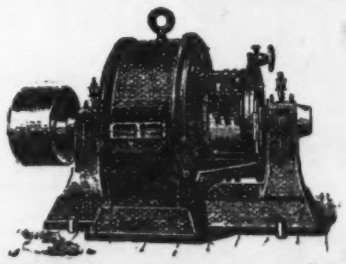

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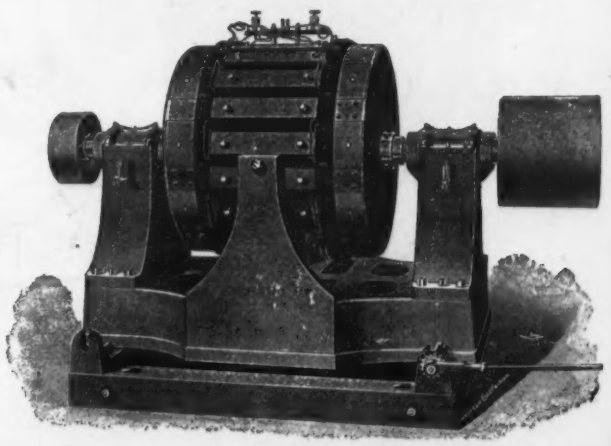

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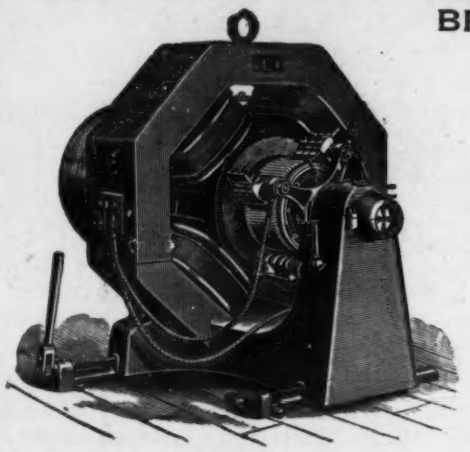

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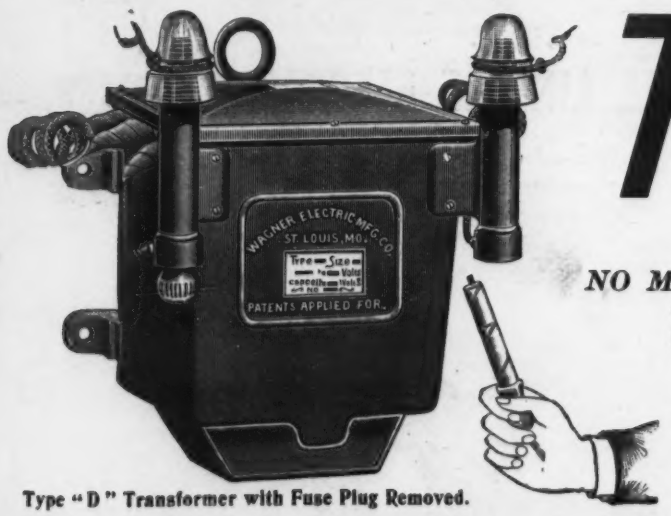

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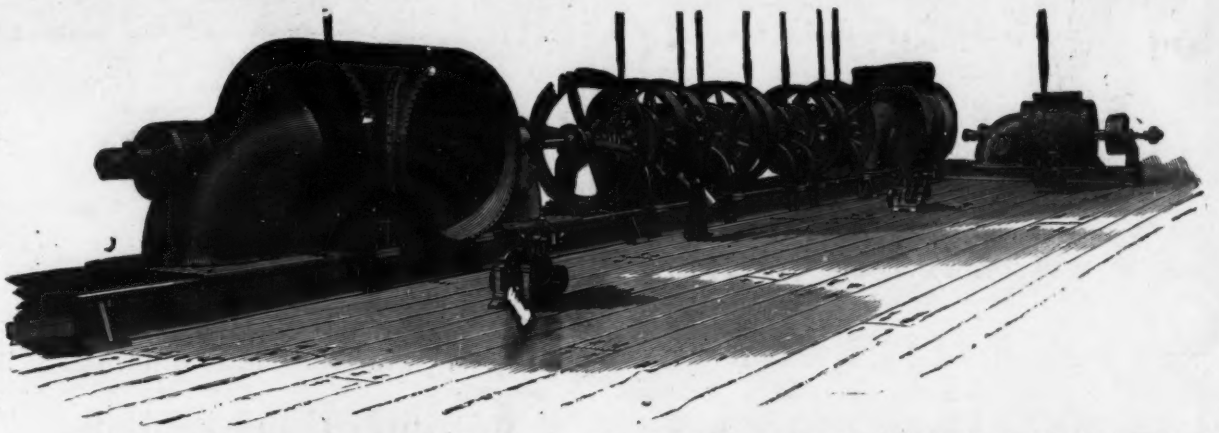

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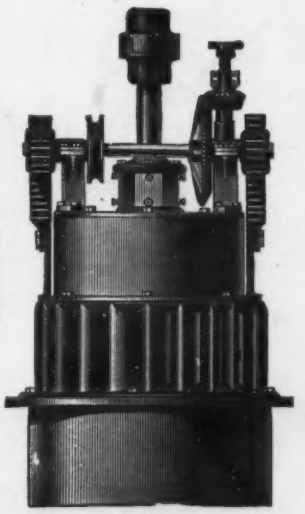

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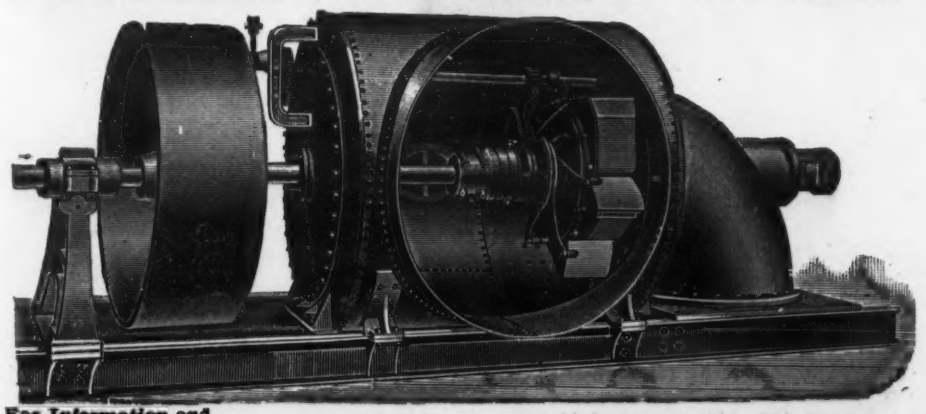

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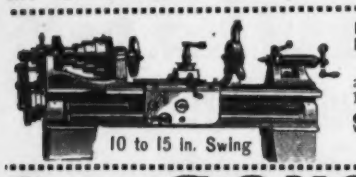

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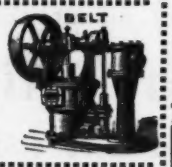
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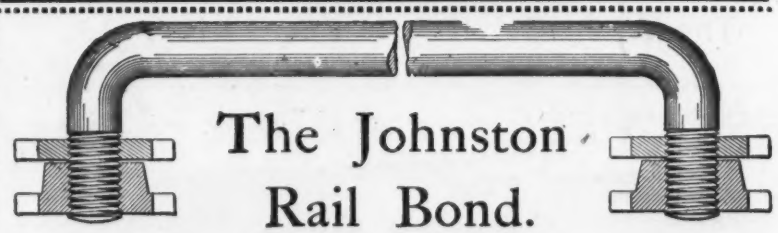

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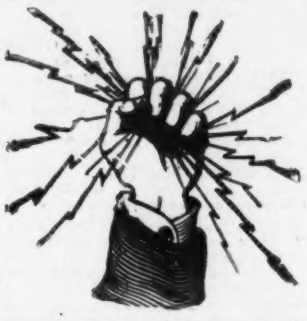

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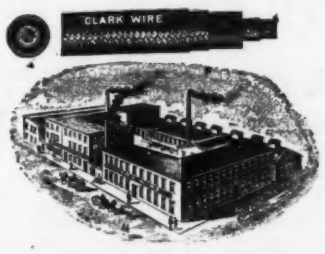

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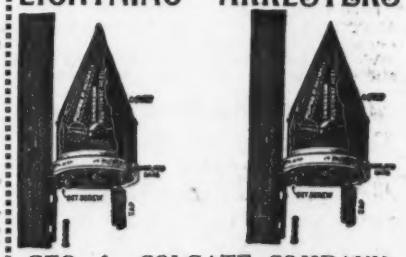

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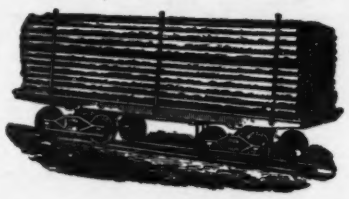

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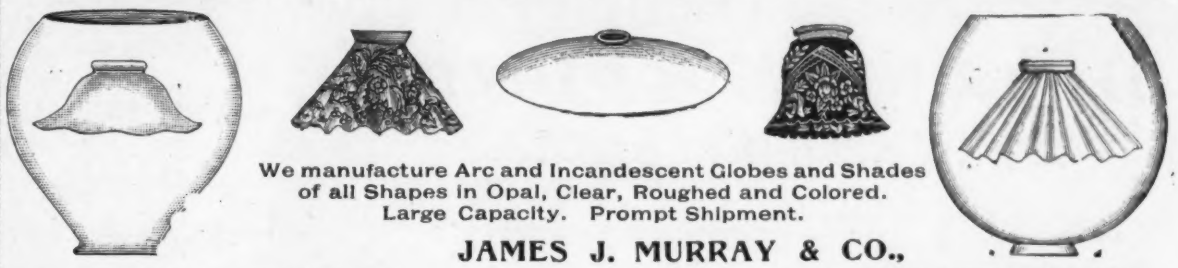

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W. L. TROWBRIDGE, Mayor.

Notice to Contractors for Electric Light Plant.

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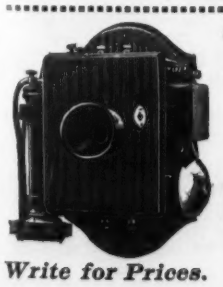

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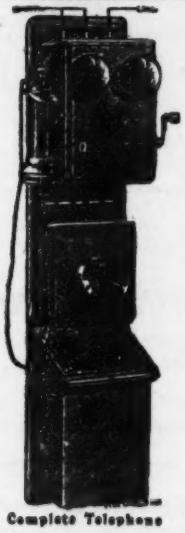

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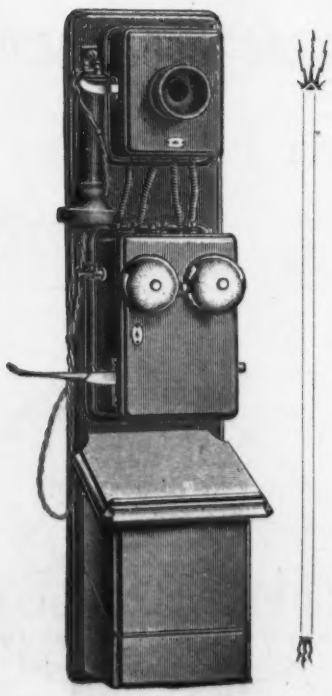

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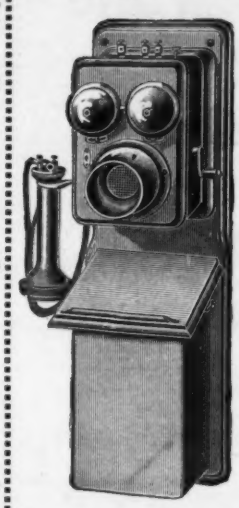

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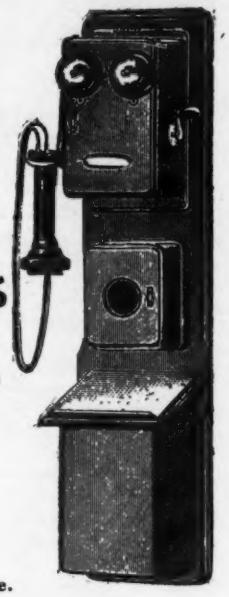

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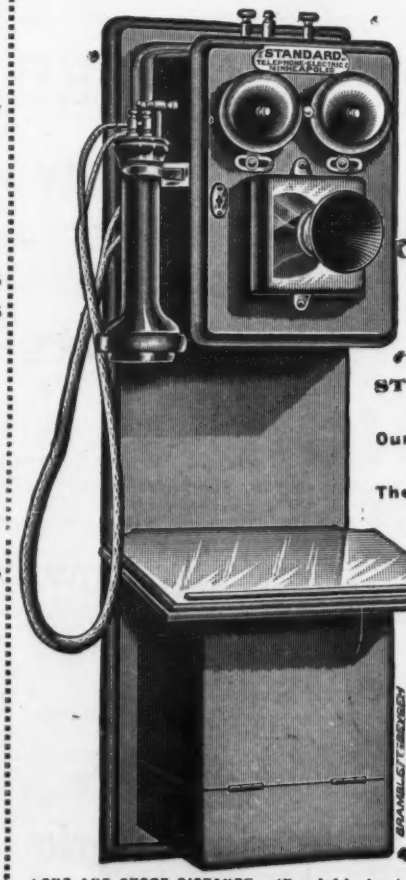

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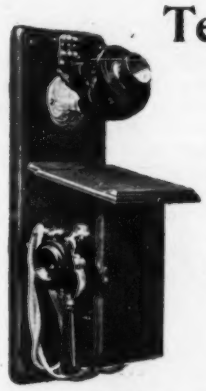

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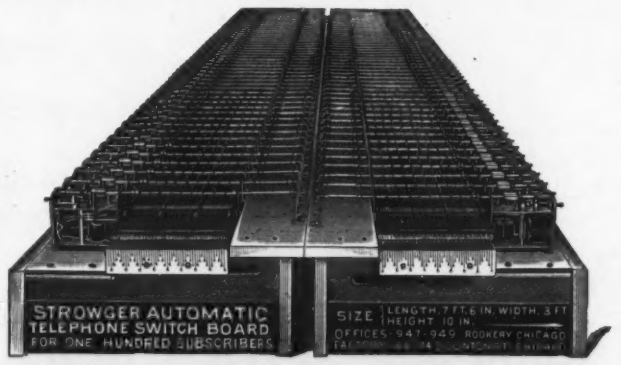
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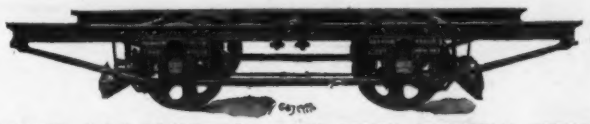

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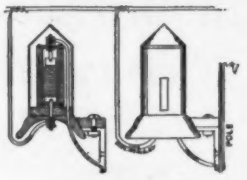

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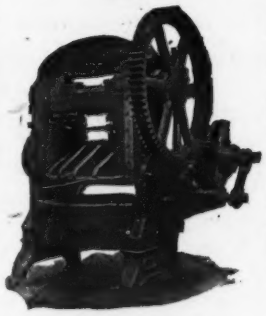

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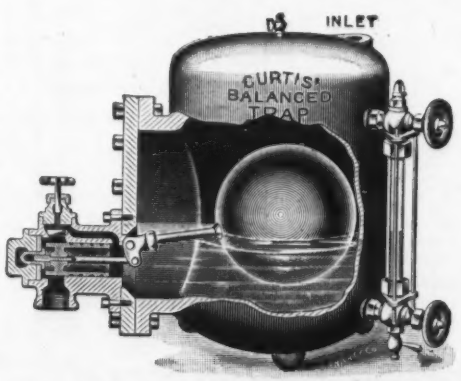

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MEASUREMENT OF ELECTRIC RESISTANCES. 65

By far the preferable method of determining resistances is by means of a device invented by Wheatstone, called the electric bridge; or, as it was originally called, the electric balance, because in it a known resistance is balanced against an unknown resistance.

The operation of the electric bridge or balance is based on the fact that no current will flow through a conductor the terminals of which are connected to points that are of the same difference of potential.

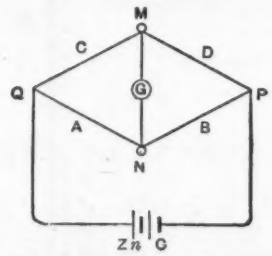

FIG. 31.—ELECTRIC BRIDGE.

A simple form of electric bridge is shown in Fig. 31. *A, B, C, D,* are electric resistances called the arms of the bridge. Any of these resistances can be determined, provided the absolute value of one and the relative values of the other two are known.

These resistances are arranged in the manner shown, and the terminals *Zn* and *C*, of the voltaic battery, are connected to the points *Q* and *P*. The

CONTENTS.

I. The Measurement of Electric Currents.—II. The Measurement of Electromotive Force.—III. The Measurement of Electric Resistances.—IV. Voltaic Cells.—V. Thermo-Electric Cells and other Electric Sources.—VI. The Distribution of Electricity by Constant Currents. VII. Arc-lighting. —VIII. Incandescent Electric-lighting.—IX. Alternating Currents. X. Alternating Current Distribution.—XI. Electric Currents of High Frequency.—XII. Electro-Dynamic Induction. —XIII. Induction Coils and Transformers —XIV. Dynamo-Electric Machines.—XV. Electro-Dynamics. — XVI. The Electro-Motor. —XVII. The Electric Transmission of Power. —XVIII. Review: Primer of Primers.

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A HUNDRED YEARS AGO AND TO-DAY. 33

In the same connection should be mentioned Dr. Franklin,* who, in 1748, set fire to spirits of wine by a current of electricity sent across the Schuylkill River, using the river and earth as a return circuit. These

*Concerning Franklin's original experiment of transmitting an electric shock across the Schuylkill and firing spirits of wine thereby, the following description is given by Franklin on page 37, of a work entitled "Experiments and Observations on Electricity, made at Philadelphia in America by Benjamin Franklin, L.L.D. and F.R.S. published in London in 1769 as follows:—

"Chagrined a little that we have been hitherto able to produce nothing in the way of use to mankind; and the hot weather coming on, when electrical experiments are not so agreeable, it is proposed to put an end to them for this season, somewhat humorously, in a party of pleasure, on the Banks of the *Skuylkil.** Spirits, at the same time, are to be fired by a spark sent from side to side through the river, without any other conductor than the water; an experiment which we some time since performed, to the amazement of many.† A turkey is to be killed for our dinner by the *electrical shock*, and roasted by the *electrical jack*, before a fire kindled by the *electrical bottle;* when the healths of all famous electricians in *England*, *Holland*, *France* and *Germany*, are to be drank in *electrified bumpers*,‡ under the discharge of guns from the *electrical battery*."

*"The river that washes one side of *Philadelphia*, as the *Delaware* does the other; both are ornamented with the summer habitations of the citizens, and the agreeable mansions of the principal people of this colony."

†"As the possibility of this experiment has not been easily conceived, I shall here describe it.—Two iron rods, about three feet long, were planted just within the margin of the river, on the opposite sides. A thick piece of wire, with a small round knob at its end, was fixed to the top of one of

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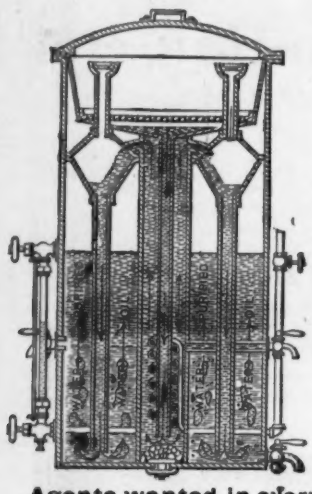

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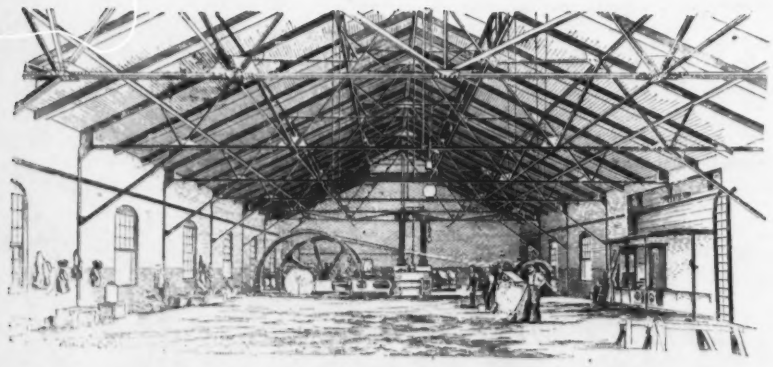

INTERIOR OF POWER HOUSE, FOR THE SCRANTON TRACTION CO., AT SCRANTON, PENN.

The above illustration is taken direct from a photograph and shows the interior of an engine room or Power House which was designed and built by us for the Scranton Traction Co., at Scranton, Penn. The building is 60 ft. wide and 120 ft. long, the frame work being entirely of steel. Between the steel side posts is placed a light brick wall to protect the interior from the weather, and ventilation is secured by a monitor the full length of the building, with swinging sash on the sides. The roof is covered with slate secured to the roof plank.

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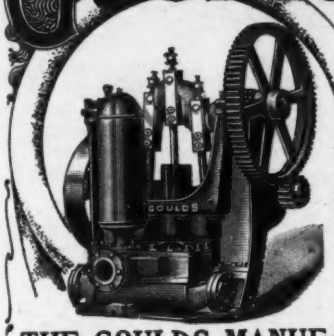

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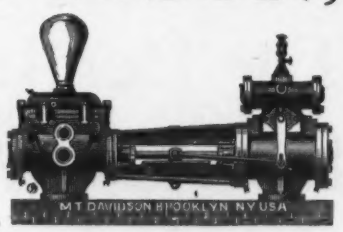

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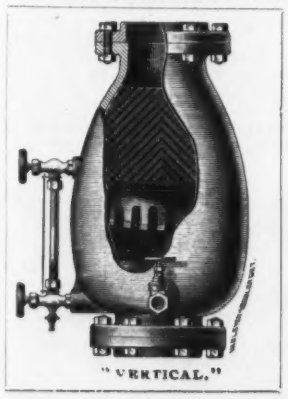

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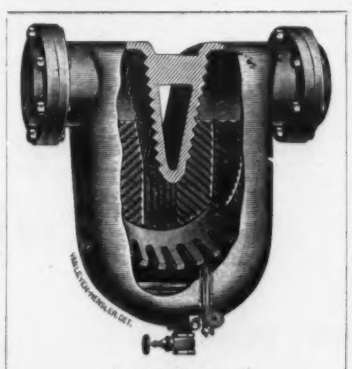

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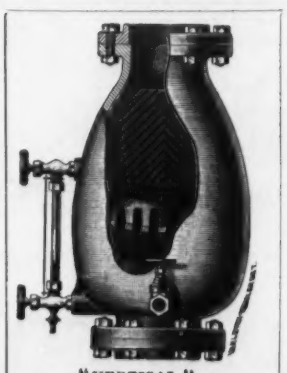

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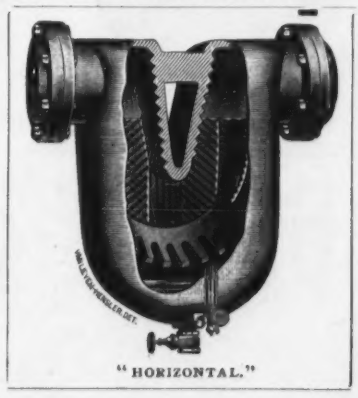

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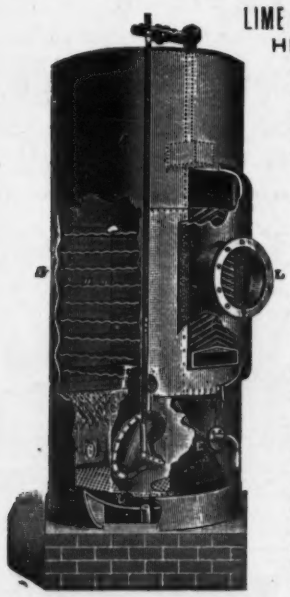

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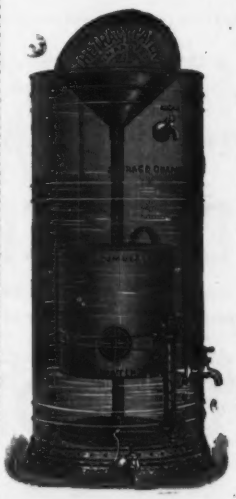

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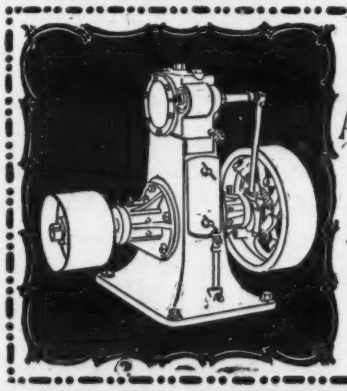

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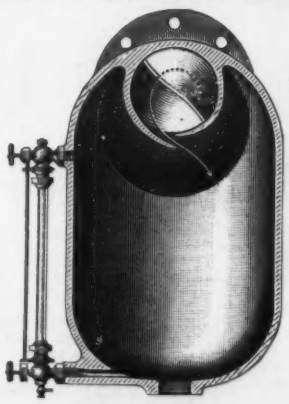

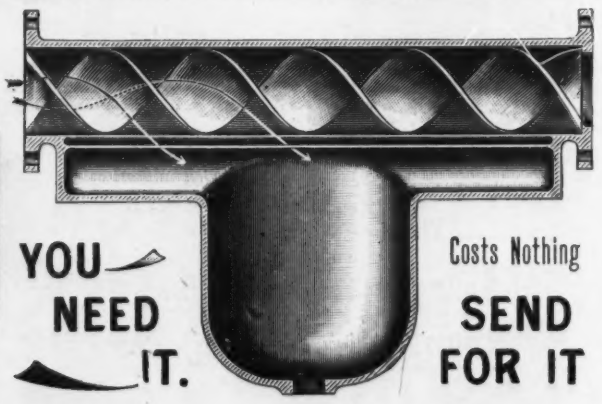

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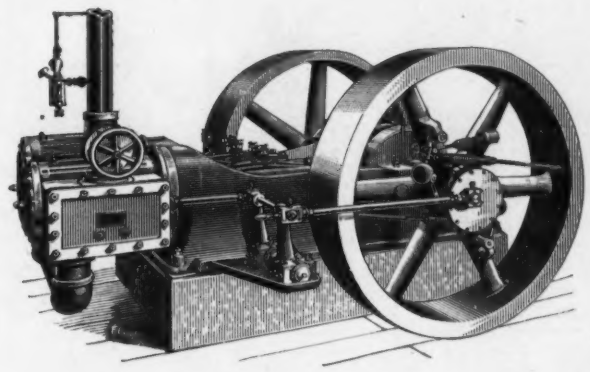

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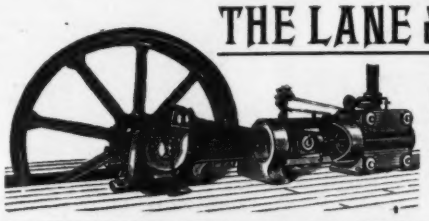

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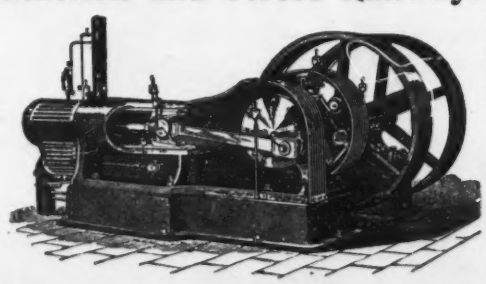

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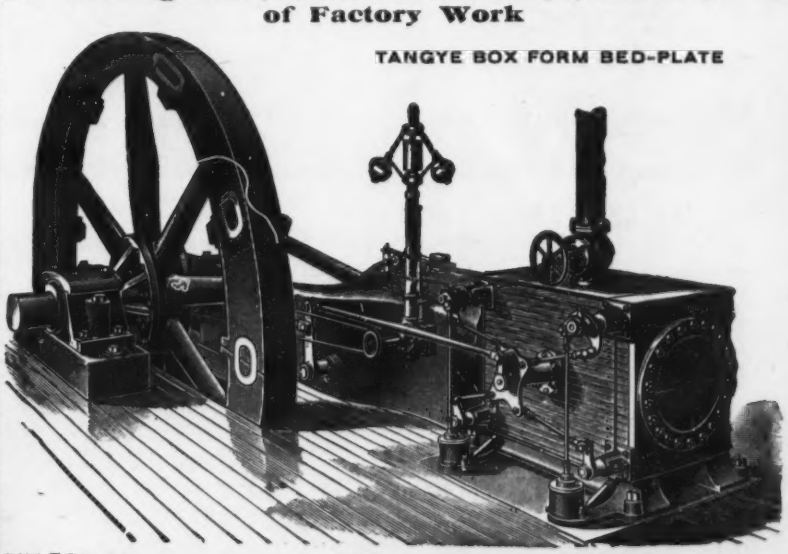

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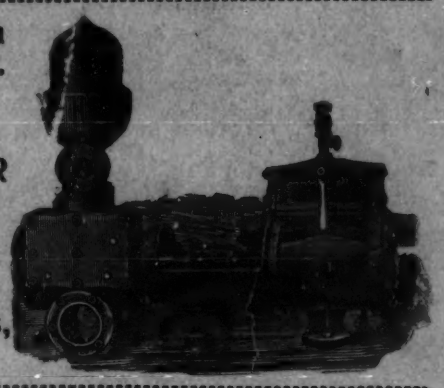

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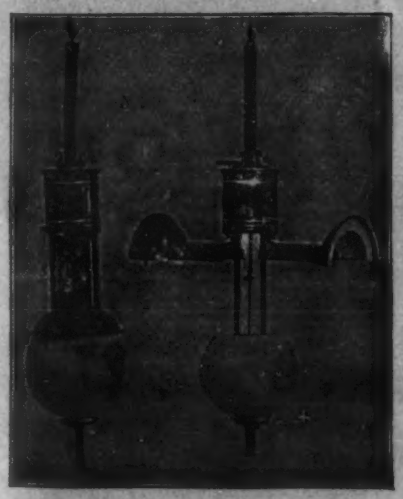

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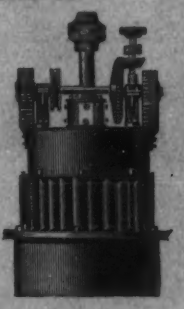

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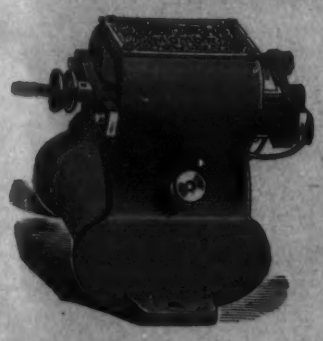

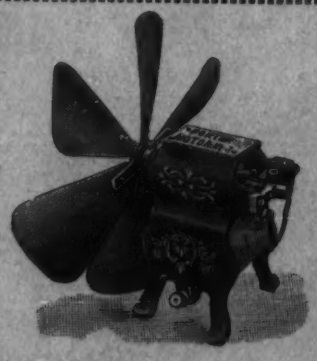

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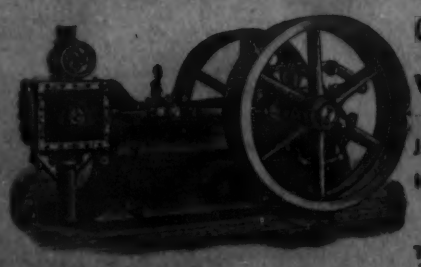

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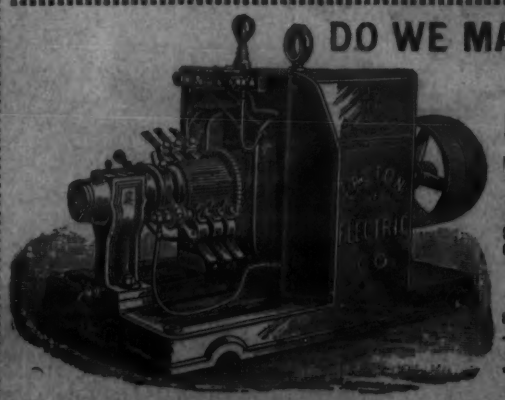

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